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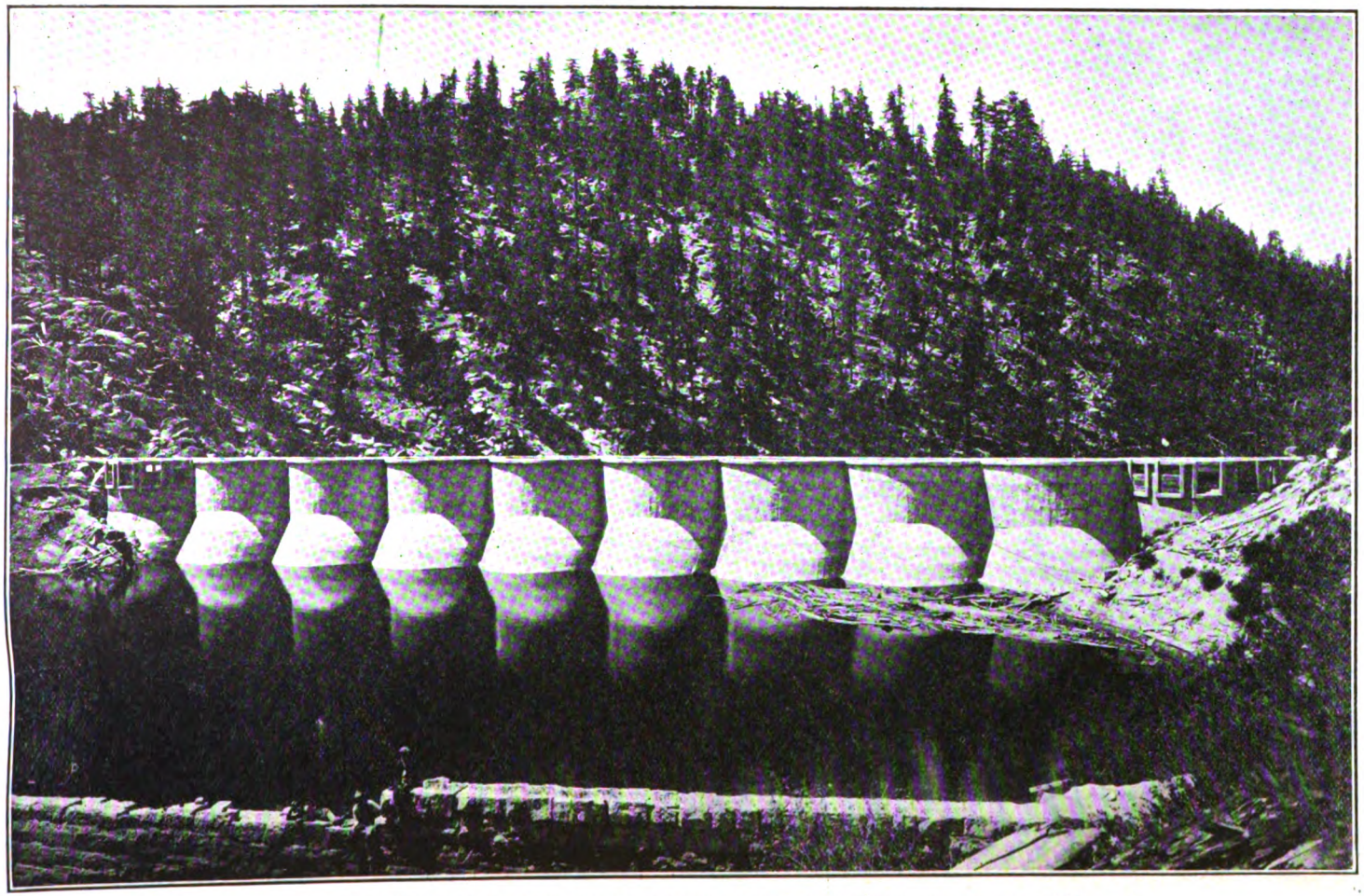

THE NEW BIG BEAR VALLEY DAM, SHOWING OLD DAM IN THE FOREGROUND. SEE PAGE 458.

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EDITORIAL

REPORTS of the activities of the Conservation Congress recently held confirms the belief that conservation and conversation are the present-day Siamese twins that always make their appearance together.

NOW that the Los Angeles aqueduct has been formally opened and water turned in, the critics will have to hasten to justify their many predictions of faulty construction and incorrect engineering.

OPPOSITION in the Senate to San Francisco's Hetch-Hetchy water-supply project thus far seems to be based on the old question of states' rights *versus* federal control rather than any objection to the plan *per se*. The question of states' rights, like the poor, seems destined to be always with us. It was nearly fought to a finish in 1860-1864, and those of us who are vitally interested in Hetch-Hetchy would like the privilege of being assured of a drink of pure water when we want it, and leave it to the 'greatest deliberative body in the world' to settle the states' rights question at their august convenience.

ANNOUNCEMENT of the completion of the first unit of the Lake Spaulding power project of the Pacific Gas & Electric Company is of more than passing interest. The present height of the dam will permit of developing 33,000 horse-power at Drum station, the first of six successive power generating plants, the ultimate aggregate development being 150,000 horse-power. The water, after release at the last power station, will be used for irrigating 75,000 acres of Placer county land. The cost of the work done thus far is $5,000,000 and includes the construction of a 4450-foot tunnel connecting the Bear Valley and Lake Spaulding dams, a 9-mile ditch from the outlet of the tunnel to the Drum forebay and having a capacity of 400 second-feet. Drum forebay required the removal of 350,000 cubic yards of material and has a surface area of approximately 13 acres. Four pipe-lines about 6000 feet long each carry the water to the wheels. These lines range from 72 to 54 inches in diameter, the operating head being 1375 feet. The present height of the Lake Spaulding dam is 242 feet, which was attained on November 17. Pouring concrete was commenced early in July 1912 and required 6 months for completion. In all, 155,000 cubic yards of concrete was placed at the remarkable rate of 1000 yards per day, which is said never to have been equaled in concrete dam construction. Work is being continued on the installation of machinery for the balance of the plants, and it is said that four of these will be in operation early in 1914. Congratulations are due Mr. F. G. Baum and his associates on the practical completion of a big task well done.

HYDRAULIC ENGINEERS will be greatly interested in Mr. W. F. Durand's report of his investigation of surge phenomena by means of model experiments. The physical characteristics of water presented many baffling problems in the way of providing for

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load fluctuations in hydro-electric power plants. These problems hinge principally upon the incompressibility of water and the inertia of the mass. In order to prevent rupture of pipe-lines by water ram induced by the quick closing of valves when the load suddenly drops, surge chambers are provided as a reservoir for the water thus shut off from the wheel. A retarding head is thus obtained that will gradually diminish the velocity of the water from that existing at the time when closure of the regulating valve commences, to that required to meet the altered load conditions. Due to the inertia of the mass of the water and to its incompressibility, this change in velocity is not accompanied by a uniform rise or fall of water in the surge chamber. On the contrary, a series of fluctuations or surges takes place of diminishing magnitude until the water-level in the surge chamber has been reached that corresponds to the changed velocity required in the pipe-line. As the phenomena of surge chambers are both complex and numerous, and hinge upon the determination of the many variable elements, it is evident that close regulation of a hydraulic prime mover depends upon the accuracy of surge chamber design as applied to the governing mechanism in each individual case. We do not know whether attention has been directed before to the possibility of investigating these phenomena by means of model experiments, but we do not believe that so thorough and clear an exposition of the subject has ever been presented by any other student of hydraulics. Mr. Durand has placed us all in his debt through the publication of the result of his investigations, and incidentally it again directs attention to the obligation of the practising engineer to the scientific investigator, without whom the progress of the world would cease.

DURING a recent visit in San Francisco, Mr. F. H. Newell, Director of the United States Reclamation Service, again called attention to the evil that may be done by unprincipled land speculators. Many settlers on government irrigated lands were deluded by misrepresentation on the part of speculators as to what they might expect as to crop conditions, and as a consequence a large number of them are insufficiently financed. Many are having a struggle to pay for their lands and keep up their water charges. In a newspaper interview, Mr. Newell says:

"The original homesteaders, finding that they could make a bigger profit on their investment by selling than by farming the land, soon sold to speculators, who unloaded on settlers at highly inflated values. The farmers are now finding it very hard to meet their payments on the purchase price out of the profits of the soil. To help them, the Government has in many places permitted the settlers to defer their payments for their water rights. Under the Salt River project this amounts to $50 an acre, payable in ten annual installments. This charge on the 200,000 acres to which water is supplied is intended to recoup the Government to the extent of the $10,000,000 which the project cost. In addition to deferring the water costs, the Reclamation Service is conducting an active educational campaign in which it seeks to teach the farmer to make the highest possible use of his land, and thus to make the quickest escape from his financial worries.

"This year the crops raised in the Salt River valley under irrigation from the Roosevelt dam were worth from $7,000,000 to $8,000,000. The total cost

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of the project was $10,000,000. We feel that the thing is a success if it thus produces each year crops worth as much or nearly as much as the total original cost of the works."

As is usually the case, the innocent suffer with the guilty, and it is unfortunate that any impression should go abroad that irrigated farms are unsuccessful because in some instances settlers take too much for granted and rush into schemes without sufficient finances or without an adequate conception of what lies before them. Farming nowadays is a science requiring careful study and skillful handling. In it there are possibilities for financial success and personal independence that are afforded by few, if any, other occupations. But those who think they may bask in the sunshine and let Nature do the rest are apt to blame farming as an occupation rather than themselves when the inevitable day of reckoning comes.

San Francisco's New Wharves

Anticipating a greatly increased ocean traffic coincident with the opening of the Panama canal, the people of California authorized a bond issue of $9,000,000, dated July 2, 1911, and maturing July 28, 1985, for the purpose of new pier construction. At an auction that took place at Sacramento a few days ago, a syndicate of bankers composed of N. W. Halsey & Co. and E. H. Rollins & Sons purchased $4,675,000 par value of these bonds at prices that would make the interest yield 4.3875 per cent. At a recent meeting of the Board of State Harbor Commissioners, plans for various improvements were adopted that provided for the expenditure of more than $1,000,000. Included in these plans are two piers to replace present piers No. 6 and 8 known as Howard street wharves No. 1 and 2. These piers will be 140 feet wide and 600 feet long and will be constructed of creosoted piling. Plans and specifications were also approved of piers No. 34 and 37. The former will be 200 feet wide by 900 feet long, and the latter 200 feet wide by 950 feet long; both will be constructed of creosoted piling.

This announcement has evoked a storm of criticism by reason of the type of construction adopted, and at first glance it would appear distinctly disappointing that in the light of present day knowledge, a temporary type of construction should be adopted to meet the requirements of a permanent need. There is much to be said on both sides of this question, however. In the issue of July last Mr. Jerome Newman, in comparing concrete and creosoted piling, gives the following tabulation on the basis of cost per square foot per year:

	Creosoted pile.	Reinforced concrete.
Interest at 4½ per cent..	$0.0450	$0.1463
Maintenance assumed ...	0.0500	0.0125
Replacement 12 years....	0.0681	.....
Sinking fund 75 years...	0.0022	0.0077
Insurance	0.0060	.....
Total per square foot..	$0.1713	$0.1665

Mr. Norman M. Halcombe in a contribution to the 'Discussion' section of the September issue gives:

	Creosoted pile.	Reinforced concrete.
Interest 75 years at 4½%.	$0.0450	$0.1463
Maintenance assumed ...	0.0500	0.0125
Replacement 12 years...	0.06656	*0.0026
Sinking fund 75 years...	0.00223	0.0072
Loss of revenue fund 12 years	0.0052	.....
Insurance	0.0060	.....
Total	$0.17499	$0.1686

*100 years.

Mr. Halcombe states further that "The interest on first cost is the principal item in the cost of the reinforced

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structure. The interest on first cost in both cases ceases after 75 years, being paid off by the accumulated sinking fund which is also eliminated. Taking the life of the concrete structure at 100 years, the annual cost of each structure will be:

	Creosoted pile.	Reinforced concrete.
Maintenance assumed	$0.0500	$0.0125
Replacement 12 years	0.0666	.....
Insurance	0.0060	.....
Total annual cost per sq. ft. for last 25 years.	$0.1226	$0.0125

Difference in favor of concrete per square foot, $0.1101.

Another point to which Mr. Halcombe directs attention with respect to the creosoted pile type of construction is the loss of revenue during periods of reconstruction. On the basis of a wharf 200 by 800 feet with the annual rental of $25,000 and allowing six months for its replacement once in twelve years, or with eight replacements in one hundred years, there is a total loss due to this cause of $100,000. Providing for this by means of a sinking fund, the comparative cost per square foot per year becomes $0.1632 for the creosoted pile construction and $0.1320 for reinforced concrete, a difference in favor of the latter of 3.12c. per square foot per year. As thirteen new wharves are to be constructed, and each has from 75,000 to 160,000 square feet of surface, the increased cost of the creosoted pile construction as compared to reinforced concrete amounts to $52,728, which is the interest at 4 per cent on $1,325,000.

In a reply to Mr. Halcombe's statement, Mr. Newman concedes the apparent accuracy of the figures cited, but directs attention to considerations other than cost that influenced the selection.

Seventy-five years is a long time, and who can say what may take place within that period to render radical changes imperative? Assuming the life of creosoted pile construction at only 12 years, and that of reinforced concrete at 75 years, the difference in cost is $0.0048, less than half a cent per square foot. On the other hand, we have to pay but ½ cent per square foot for the privilege of building any type of wharf or pier we please at the expiration of 12 years. By that time we shall know many things about which we can do little more than guess at the present. What influence the opening of the Panama canal will exert on ships and shipping can only be surmised. That many changes will take place is conceded. Therefore is it not wise to install a certain number of admittedly temporary structures in order that, when the canal is open for traffic, San Francisco may be ready for all comers? Then when the business of the port has been reduced to a matter of ordinary routine, and new standards and methods of freight carrying and handling have been established, let us build then the finest permanent piers possible when with ten years added knowledge back of us we will have some basis upon which to forecast the future. This is no discussion of the comparative merits of reinforced concrete and creosoted piling. There can be no comparison. Reinforced concrete properly constructed is as enduring as time itself, and it will be many years before the limit of its application may be found. The pier situation in San Francisco at present, however, is a matter of economics rather than engineering. The question before the Board of Harbor Commissioners was, "How shall we provide a series of structures that will be adequate to care for a traffic the precise nature of which we do not know, and that when obsolete and thrown into the discard will have earned their cost during the period of usefulness?"

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REVIEW OF THE MONTH

WHILE winter is now upon us, an occasional glimpse of sunshine through the clouds of business depression gives promise of a bright and productive spring. The currency bill is still before the Senate, and opinions have been expressed to the effect that it is doubtful whether it may be brought to a vote before February next. Great pressure is being brought to bear by large financial interests to have the, to them, many objectionable features at least modified. One of the principal objections to the bill urged by bankers is the establishment of twelve federal reserve banks in which National banks must deposit that portion of their legal reserve that has heretofore been sent to New York, Chicago, or St. Louis, chiefly New York, as provided by the existing National bank act. Under the present law, National banks in the country keep a cash reserve of 15 per cent, a portion of which they may deposit with National banks in reserve cities. The latter banks are required to keep a 25 per cent cash reserve, a portion of which they may deposit with National banks in the three central reserve cities. In these banks but 25 per cent cash reserve must be kept. So it seems that some 7106 country banks are continually depositing money with 367 banks, and that these in turn are doing the same with 52 banks in the three central reserve cities. Hence the opposition from Wall Street bankers to the Owens-Glass bill, which aims to promote the use of money made in a district for the upbuilding of that district, rather than to furnish the wherewithal for stock gambling in New York or Chicago.

ORDINARILY, labor troubles are regarded as an inevitable accompaniment of the spring season. Judging by recent labor agitation in railroad circles, however, strikes are encroaching even upon the winter months. Approximately 2500 train and engine men on the Atlantic division of the Southern Pacific's Sunset lines walked out on November 13 after six months of futile negotiations. A list of 67 grievances against the railroad company makes up the complaint by the men, of which the question of wages and hours is of the most importance. Appeal was made by the railroad company at the eleventh hour to the new federal Board of Mediation and Conciliation, but not in time to prevent a walkout. After a few days, however, both parties to the controversy agreed to accept arbitration of their difficulties, so traffic has been resumed and the threatened loss of millions of dollars to the sugar and rice producers of Louisiana has been averted.

AN interesting forecast of the probable result of the forthcoming arbitration proceedings with regard to employees of the Southern Pacific Company's Sunset route is a decision just announced by the Board of Mediation and Conciliation in the case of employees on the Eastern railroads. It will be remembered that this controversy was brought to an issue in May last and that through the operation of the Newlands Act a serious tie-up was

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averted. The Board has been carrying on almost continuous hearings of the case ever since, and on November 10 rendered a decision authorizing an increase in wages for conductors and trainmen on Eastern roads averaging about 7 per cent and totaling $6,000,000 annually. One hundred thousand men will share in the increase. Forty-one railroads in all are involved, and their two representatives on the Board, as was to have been expected, rendered a dissenting opinion. In reaching the award, the Board ruled principally against the employees on four out of five points submitted as reasons why the increase should be granted, but found for them on the fifth, which was our old friend 'the increased cost of living.' It was determined that since 1909 the cost of living had increased 7 per cent. We may now expect a request from the railroads to the Interstate Commerce Commission to authorize increases in freight rates, by reason of the increased cost of operating railroads. The increased freight rates will again increase the cost of living, when we may expect another demand on the part of labor for increased pay. It seems that the purchasing power of a dollar decreases as the number of dollars obtainable by the average man increases, and it is a question whether the great increase in wage rates that has taken place during the last fifteen years has been of any real benefit to labor after all.

SINCE Mr. Benjamin F. Bush assumed the presidency of the Western Pacific Railroad Company, a marked activity has resulted. Appreciating the fact that a trunk line without feeders is not of much account as an investment, Mr. Bush has been active in arranging to find them for the Western Pacific. Negotiations have been under way for some time for the purchase of the Oakland, Antioch & Eastern electric railway system, carrying with it the Nevada County narrow-gauge steam road that runs from Colfax, on the main line of the Southern Pacific, by way of Grass Valley to Nevada City. The acquisition of these two feeders by the Western Pacific would be an excellent move, and would enable it to tap an exceedingly rich agricultural and mining territory, and materially increase both the freight and passenger traffic. It is understood that the actual consummation of the purchase will hinge upon the attitude of New York bankers, who will be asked to finance a bond issue for providing the necessary funds.

OIL MEN have been greatly interested in a report now confirmed that the General Petroleum Company has at last been financed. Rumor has been busy for many months regarding the sale of the General Petroleum properties to the Royal Dutch-Shell company. It has now been announced, however, that through the efforts of Mr. John Barneson and Mr. Eugene De Sabla, a British syndicate headed by Andrew Weir & Company, London shipping merchants, has formed a holding company which will take over the properties of the General Petroleum Company, will probably exercise an option on the Union Oil Company's stock, and will furnish all necessary funds for future financing of the Company. The formality of signing the agreement is contingent upon the delivery by the General Petroleum underwriters of one-half the outstanding bonds in exchange for stock. It is stated that the holding company will be authorized to issue £10,000,000 of 7 per cent cumulative preference shares and ordinary shares at a par value of £5,000,000. The total authorized capitalization, therefore, will

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be approximately $75,000,000, of which two-thirds will be preference and one-third ordinary. The preference shares, however, will have no voting power. In the meantime, the syndicate has obligated itself to furnish $3,000,000 in cash for the use of the General Petroleum Company, of which $1,000,000 has already been supplied and $2,000,000 will be on call after January 1, 1914. As the Company's requirements for the present and the immediate future are $1,800,000, this will leave $1,200,000 for working capital and for development.

OF the total amount of stock authorized, $35,000,000 has been provided for purchasing control of the Union Oil Company under option granted some time ago to the General Petroleum Company, should the Weir syndicate deem it advisable. The syndicate, however, has not obligated itself to take up this option, and it is understood that Messrs. Andrew Weir and R. Tilden Smith are due to arrive in New York on December 10 on their way to California to inspect the Union Oil Company's properties. The decision will be rendered on their return to London, although thirteen months remain in which to effect this transaction. The General Petroleum Company has an authorized capital stock of $50,000,000, and in May 1913 there was outstanding $34,814,600 and also $12,554,000 in 6 per cent sinking fund twenty-year bonds out of an authorized issue of $25,000,000. In addition to these securities there is outstanding $3,000,000 notes which are secured by a deposit of $6,000,000 of the 6 per cent bonds and $9,000,000 in stock. The Company controls the General Pipe Line Company which was formed for the purpose of building the pipe-line from the Midway fields to San Pedro harbor. The cost of the pipe-lines is reported to have been over $5,000,000. The Company also owns or controls approximately 25,000 acres of oil lands in California; properties in Mexico purchased at a cost of $5,000,000, and a controlling interest in the Trumble Refining Company. The Union Oil Company, upon which the General Petroleum Company has an option calling for the payment of $33,333 monthly, has an authorized capital stock of $50,000,000, of which $31,147,000 is outstanding. This Company also has a funded debt of $6,695,000, of which $5,695,000 is in first lien sinking fund 5 per cent bonds and $1,000,000 in convertible 6 per cent debenture notes. The Company owns and controls a number of producing, refining, and pipe-line companies, including the Producers' Transportation Company with over 200 miles of pipe-line. Its sales of crude oil last year were valued at $17,219,821.

A DECISION has recently been rendered by the United States Circuit Court of Appeals in St. Paul that will be of far-reaching effect in determining land title cases in which companies or private parties have made improvements on federal property without obtaining proper authority from the Secretary of the Interior. The case was that of the United States *v.* Utah Power & Light Company. In 1912 the United States District Attorney for Utah filed suit against the Telluride Power Company, alleging that the corporation had a reservoir, flume, and conduit on the Bear River National Forest without having been granted permission, or without the power company having asked permission. The Telluride Power Company having been succeeded by the Utah Power & Light Company, the latter assumed the defense. The argument for the defense was that an act of Congress had authorized the con-

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struction and maintenance of power-plants on forest reserves, while the position of the Government was that the law only gave such permission in connection with the operations of mining and irrigation properties. The judge in the lower court ordered the dismissal of the action in accordance with the motion of the attorneys for the power company. Appeal was taken by the Government, with the result that the decision of the lower court was reversed, the decision stating that the Utah Power & Light Company has no rights to the land it occupies in the Bear River National Forest in Cache county, Utah. It is believed that the case will now be taken to the Supreme Court of the United States, although the decision of the power company in this respect has not been officially announced.

CONTROVERSIES over the best methods of road construction are by no means confined to California. Manufacturers of oil or refined asphalt strenuously object to a decision just announced by the State Highways Department of New York that the specifications for natural asphalt shall be separate from those for oil asphalt. Oil asphalt manufacturers say that this decision will give a practical monopoly of material to the Barber Asphalt Company. The $70,000,000 remaining of the $100,000,000 bond issue for new roads is a prize worth fighting for. The adoption of separate specifications by the board is said to afford an opportunity for discrimination. This is the cause of protest by the oil asphalt manufacturers, who claim that a specification should be adopted that will apply equally to either product. If this is done, awards of contracts for asphalt will be placed with the lowest bidder whose material meets the prescribed test and specifications. Competition will thus be open and free, while by the ruling just made, an opportunity is afforded to specify certain classes of material for specific sections of road.

NEWS of a suit recently brought by the Natural Soda Products Company against the city of Los Angeles brings out an interesting question of water rights. The Los Angeles aqueduct diverts water from the Owens river for domestic purposes. Naturally, in providing for the future, the engineers for the project designed for a capacity of about 80 per cent greater than their present needs. It is proposed to market this surplus water for irrigation purposes wherever possible along the line of the aqueduct. The Natural Soda Products Company alleges, therefore, that such use is not a matter of public convenience and necessity, but makes of the aqueduct a commercial enterprise. It is also contended that the diversion of the waters of the Owens river will dry Owens lake and thereby put an end to a process for extracting cheaply 70,000,000 tons of soda from Owens lake. We will not venture to predict the outcome of the suit, but the situation is certainly interesting, especially to the people of Los Angeles.

THE Secretary of Agriculture has just granted to the Skagit Power Company a permit for the development of two water-power sites on the Skagit and Cascade rivers in Skagit county, Washington, within the Washington National Forest. The two projects will include concrete diverting dams, conduits, and power-houses, and machinery aggregating over 50,000 hp. will be installed. Work on the Skagit project will be commenced within a comparatively short time.

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Investigation of Surge Phenomena by Means of Model Experiments

By W. F. DURAND*

THE general theory of the subject matter discussed in the present article was presented in 1911 as a brief appendix to a paper read before the San Francisco Section of the American Society of Mechanical Engineers and later at the Cleveland meeting of the Society in June 1912. Further development of the subject seems to indicate the general availability of the experimental investigation of surge chamber phenomena by means of models, and it has therefore seemed desirable to give a somewhat more extended discussion of the subject. It will first, however, be desirable to refer briefly to the general phenomena of surge chamber action.

The typical hydraulic power-plant consists of three main parts: (1) a reservoir of water; (2) a power-house with hydraulic prime movers; (3) a connecting water conduit between the two.

The regulation of power development in order to meet the demands of a rapidly varying load requires provision for a correspondingly rapid variation in the quantity of water delivered to the wheels. There are, however, sharply defined limits to the rapidity with which changes in the velocity of water in a closed conduit can be brought about. No matter how suddenly the control valves at the wheels may be opened, the acceleration of the water will be no greater than that determined by the hydraulic constants of the conduit line, and for rapid movements of the valve the time required to pass from an initial velocity v_1 to a greater velocity v_2 will depend primarily on such hydraulic constants. Again, if the control valves at the wheels be suddenly closed, the movement of the mass of water in the conduit line cannot be as suddenly arrested, and the attempt to bring about such a sudden arrest will develop, through the inertia of the water, a rise in pressure in the line which may easily become dangerous in amount. These difficulties which arise in connection with either acceleration or retardation become rapidly aggravated with increase in length of the water conduit, so that beyond certain narrow limits some measure of relief for the situation becomes imperative. It is here that the surge chamber enters as a means for meeting the demands of the situation. The manner of its operation will be readily understood from the diagram, Fig. 1.

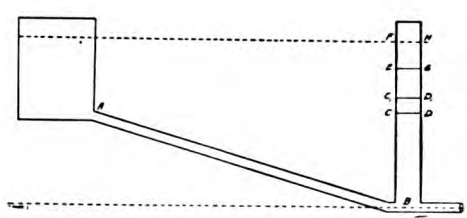

FIG. 1.

Let R denote a reservoir supplying water to a power-plant at P. Let BFH denote a stand-pipe or surge chamber relatively near to P. Let the plant be running at a steady rate of

*Professor Mechanical Engineering, Stanford University, Palo Alto, California.

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output with a velocity of v_1 in the line AB. Then let there come a sudden demand for more power and consequently more water such as would require, for steady conditions in AB, a velocity v_2. The water in AB cannot, however, be immediately accelerated from v_1 to v_2, and the first result will be that the surge chamber BFH must furnish the water corresponding to the difference $(v_2 - v_1)$. This will result in lowering the water-level in BFH below that corresponding to the velocity-friction head due to the actual velocity in AB, and this difference in level will constitute an accelerating head which will operate to raise the velocity of the water in AB, so that in the end and after a period of change, the velocity in AB will be raised from v_1 to v_2 and the level of the water BFH will be lowered from that corresponding to the velocity-friction head for v_1 to that corresponding to the greater velocity v_2.

The function of the surge chamber in such case is therefore to supply immediately and during the period of change the water which cannot be supplied from the conduit AB and reservoir R, and at the same time to develop an accelerating head which will gradually and ultimately bring the water in AB from the insufficient velocity v_1 to the final sufficient steady velocity v_2.

Again suppose instead of a sudden demand for more, that a certain amount of load is suddenly rejected. If the water is suddenly cut down at the wheels, the attempt to produce such a rapid retardation in the mass of water moving in AB would develop large excess pressures in the line which might easily become serious or dangerous in amount. In this case the surge chamber provides an outlet for the water which is coming along AB, but which is not wanted at the wheels, and in consequence the level rises in the chamber above that which corresponds to the velocity-friction head due to the actual velocity. This difference of level will then constitute a retarding head which will gradually slow down the water in AB so that in the end and after the period of change, the velocity in AB will be reduced from v_1 to some lower value v_2, and the level of the water in BFH will be raised from that corresponding to the velocity-friction head for v_1 to that corresponding to the lower velocity v_2.

The function of the chamber in this case is therefore to provide immediately and during the period of change a reservoir for the water which is coming along AB, but which is not permitted to flow to the wheels, and at the same time to develop a retarding head which will gradually and ultimately slow down the water in AB from the excess velocity v_1 to the final reduced value v_2.

It should be here noted that in the general case the desired final steady velocity v_2 with the corresponding level for velocity-friction head in BFH are only reached after a series of surgings of the water-level up and down, alternately above and below its final level, with corresponding fluctuations of the velocity above and below the final steady value v_2.

The physical explanation of this double periodic movement of water-level and velocity is found briefly in the following facts.

(1) The changing level in the chamber above or below its proper location for the velocity-friction head due to the existing velocity, produces, as above stated, an accelerating or a retarding head.

(2) This head produces an increasing or a decreasing velocity.

(3) The phases of these two changing quantities, the head and the ve-

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locity, are not the same and in consequence when the velocity first reaches the value v_2, the head producing the change instead of being O will in general still remain of some finite value and of the same sign.

(4) This results in the production of a velocity beyond v_2, either more or less as the case may be, for demanded or rejected load.

(5) This will result ultimately in extinguishing the head producing the change, but when this is accomplished the velocity instead of having the value v_2 will be a little more or a little less according as the head was accelerating or retarding.

(6) This excess or defect in velocity will forthwith develop a reverse change in the head which will in return reverse the difference in velocity, and thus the two quantities accelerating or retarding head and velocity will seesaw back and forth with rapidly diminishing amplitude of oscillation, until finally the head becomes sensibly O and the velocity reaches its final steady value v_2.

In order to discuss the details of the problem algebraically, let us use the following notation: Let

A = cross-section area of conduit.
F = cross-section area of surge chamber at water-level.
$n = F/A$.
L = length of conduit AB.
y = distance of water-level in surge chamber from initial position for steady motion with velocity v_1.
Y = distance of water-level from static level.
b = factor such that bv^2 = sum of friction and velocity heads at velocity v.
v = velocity in general.
v_1 = velocity at beginning of period.
v_2 = velocity at end of period.

Then for demanded load

$$Y = y + bv_1^2 \tag{1}$$

and for rejected load

$$Y = -y + bv_1^2 \tag{2}$$

It should be noted at this point that the actual details of the phenomena during the period of change will depend on the character of the governor action during the same period. Two assumptions may be made as follows: (a) constant power input to the wheel and (b) constant volume of water discharged. Neither assumption is quite accurate. The former is perhaps the more nearly so, but the latter results in a marked simplification in the mathematical and experimental treatment of the problem, and will therefore be assumed for the present discussion.

The equations connecting these various quantities have been many times derived in the literature of this subject,* and the detailed discussion of their derivation may therefore be omitted.

These equations are as follows.

For demanded load:

$$\frac{L}{g}\frac{dv}{dt} = y - b(v^2 - v_1^2) \tag{3}$$

$$n\frac{dy}{dt} = (v_2 - v) \tag{4}$$

For rejected load:

$$-\frac{L}{g}\frac{dv}{dt} = y - b(v_1^2 - v^2) \tag{5}$$

$$n\frac{dy}{dt} = (v - v_2) \tag{6}$$

Now suppose that there could be found a series of cases with various values of the length and size of conduit, size of surge chamber, values of the velocity, etc., but all with similar time histories of the acceleration head. To make this supposition entirely clear, we must note more definitely the significance of the term 'similar time histories'. To make the thought more definite we will assume the case

*See *Trans.* Am. Soc. Mech. Eng., 1912.

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of demanded load and increasing velocity.

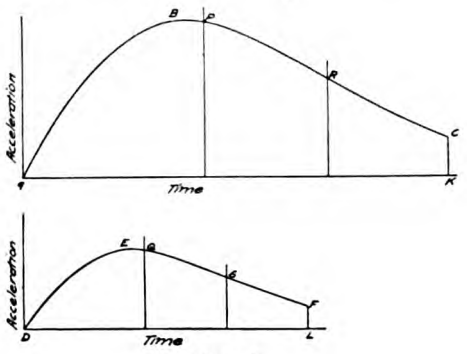

FIG. 2.

In Fig. 2 let the curve ABC denote the time history of the acceleration head for case No. 1; that is, the value, plotted on a time axis, of the difference between the actual level of the water in the surge chamber and the level where it would stand if the water in the conduit were flowing steadily and thus without acceleration at the instantaneous value of the velocity v.

Referring again to Fig. 1, CD denotes the actual level of the water during a period of demanded load change, the actual instantaneous value of the velocity being v, intermediate between v_1 and v_2. C_1D_1 represents the level which the water would take if the velocity were steady at v; that is, if the water were flowing steadily along AB, without acceleration or retardation. The difference between these two levels is then the head which is available for and which produces the accelerated motion during the period of changing velocity from v_1 to v_2. Then the curve ABC in Fig. 2 shows the time history of this accelerating head. Let DEF be similarly the acceleration curve for case No. 2. Let the abscissae AK and DL denote the time required in each case to pass from the lower to the higher velocity. Let the two curves ABC and DEF furthermore be so related that by stretching the latter m fold parallel to x and n fold parallel to Y, the two may be made identical. Two such curves are then said to be similar, and under the conditions above expressed will therefore represent similar time histories of the accelerating head. It is obvious that with two such similar curves, identical values will be indicated by using suitable scales for reading or plotting, and in short that the matter of relation between the values of the variables at corresponding points is one simply of scale ratios.

To generalize, then, we may assume an indefinite number of cases, all with different acceleration curves, but all similar in the sense of the definition. Then to every point on one of these curves which we may take as the type or fundamental, there will correspond a point on any other, the values of the time and head for which will be related to the corresponding values on the type curve by scale ratios, constant for any one pair of cases. Thus in Fig. 2, P and Q are two corresponding points the values of the coördinates for which are related by means of ratios which are constant for all other pairs of corresponding points such as R and S, etc.

We have next to determine the relation between the hydraulic characteristics of two such cases in order that the acceleration curves may be related in this general manner.

Let the fundamental characteristics of the two cases be related as follows: Ratio of:

$$\text{conduit lengths or } L \text{ ratio} = p \qquad (7)$$

$$\text{coefficients for velocity-friction head, or } b \text{ ratio} = q \qquad (8)$$

$$\text{velocities or } v \text{ ratio} = r \qquad (9)$$

$$\text{times or } t \text{ ratio} = s \qquad (10)$$

Then we have immediately as follows:

$$v^2 \text{ ratio} = r^2 \qquad (11)$$

$$b(v^2 - v_1^2) \text{ ratio} = qr^2 \qquad (12)$$

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Referring now to equation (3) it may be noted as a fundamental fact that all terms in such an equation must be homogeneous in terms of their relation ratios. That is, if any one term of the equation is related to the two cases through a ratio such as qr^2 then every other term must be related similarly through the same ratio. Hence we derive immediately:

$$y \text{ ratio} = qr^2 \tag{13}$$

$$\frac{L}{g}\frac{dv}{dt} \text{ ratio} = qr^2 \tag{14}$$

$$\frac{dv}{dt} \text{ ratio} = \frac{qr^2}{p} \tag{15}$$

But the $\frac{dv}{dt}$ ratio must equal the quotient of the v and t ratios. Hence:

$$\frac{dv}{dt} \text{ ratio} = \frac{r}{s} \tag{16}$$

and hence equating (15) and (16) we have

$$\frac{qr^2}{p} = \frac{r}{s}$$

or

$$s = \frac{p}{qr} \tag{17}$$

This gives the value of the time ratios for the two cases in terms of p, q and r.

Again the $\frac{dy}{dt}$ ratio must equal the quotient of the y and t ratios or

$$\frac{dy}{dt} \text{ ratio} = \frac{qr^2}{s} = \frac{q^2r^3}{p} \tag{18}$$

Again from (4)

$$n \text{ ratio} = v \text{ ratio} \div \frac{dy}{dt} \text{ ratio}$$

or

$$n \text{ ratio} = \frac{pr}{q^2r^3} = \frac{p}{q^2r^2} \tag{19}$$

Let d_1 A_1 D_1 F_1 denote, respectively, the diameter of the conduit (assumed circular in section), area of conduit, diameter of surge chamber (assumed circular in section), and area of surge chamber, all for case No. 1 or the type case, with similar notation with subscript 2 for case No. 2 or any case in general.

Then:

$$n_1 = F_1/A_1$$

$$n_2 = F_2/A_2$$

$$\text{and } n \text{ ratio} = \frac{p}{q^2r^2} = \frac{F_2}{F_1}\frac{A_1}{A_2}$$

$$\text{Hence } \frac{F_2}{F_1} = \frac{p}{q^2r^2}\frac{A_2}{A_1} = \frac{p}{q^2r^2}\left(\frac{d_2}{d_1}\right)^2 \text{----(20)}$$

$$\text{Whence } \frac{D_2}{D_1} = \frac{\sqrt{p}}{qr}\sqrt{\frac{A_2}{A_1}} = \frac{\sqrt{p}}{qr}\frac{d_2}{d_1} \text{--------(21)}$$

$$\text{and Volume ratio} = \frac{F_2 y_2}{F_1 y_1} = \frac{p}{q}\left(\frac{d_2}{d_1}\right)^2 = \frac{pA_2}{qA_1} \text{---(22)}$$

Collecting we have a series of ratios as follows:

1. The ratio of all similar vertical dimensions, such as maximum movement of water-level, movement for final steady conditions, movement for corresponding parts of the acceleration curve or in corresponding values of the time will equal qr^2.

2. The ratio of the time intervals for the whole or for corresponding parts of the transition phenomena will equal $\frac{p}{qr}$.

3. The ratio of the diameters of the chamber at corresponding levels will be

$$\frac{\sqrt{p}}{qr}\left(\frac{d_2}{d_1}\right) \text{ or } \frac{\sqrt{p}}{qr}\sqrt{\frac{A_2}{A_1}}$$

4. The ratio of the volumes swept through by the water surface in corresponding times will be

$$\frac{p}{q}\left(\frac{d_2}{d_1}\right)^2 \text{ or } \frac{p}{q}\frac{A_2}{A_1}$$

A case possessing both interest and importance is that involving the use of

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a spillway or weir edge overflow at the top of the chamber.

Let B = the length of such spillway.

Y_0 = height from some datum to level of overflow edge.

Y = height from same datum to surface of water.

Then $(Y - Y_0)$ = depth of water on weir and for the volume discharged in time dt we have

$$dV_1 \sim B(Y-Y_0)^{3/2}\,dt \quad \text{----------(23)}$$

The volume of flow along tunnel will be

$$dV_2 \sim vA\,dt \quad \text{----------(24)}$$

The volume represented by the increase in the water contained in the chamber will be

$$dV_3 \sim F\,dY \quad \text{----------(25)}$$

Then obviously,

$$vA\,dt \sim F\,dy + B(Y-Y_0)^{3/2}\,dt \quad \text{-----(26)}$$

$$\text{or } vA \sim F\frac{dy}{dt} + B(Y-Y_0)^{3/2} \quad \text{-------(27)}$$

This equation together with the general equation for the acceleration head as given in (5) will serve to determine the motion after the water reaches and rises above the weir edge.

To deal with the problem by means of a model we must assume the coefficients in the weir formula the same for model and for the actual case, and to determine the relation ratios for such use of the model we have then simply to apply the principle of homogeneity to equation (27). Thus:

$$\text{the } v \text{ ratio} = r$$

$$\text{the } A \text{ ratio} = \left(\frac{d_2}{d_1}\right)^2$$

$$\text{the } F \text{ ratio} = \left(\frac{D_2}{D_1}\right)^2 = \left(\frac{d_2}{d_1}\right)^2 \frac{p}{q^2 r^2}$$

$$\text{the } \frac{dy}{dt} \text{ ratio} = \frac{q^2 r^3}{p}$$

$$\text{the } (Y-Y_0) \text{ ratio} = qr^2$$

$$\text{the } vA \text{ ratio} = r\left(\frac{d_2}{d_1}\right)^2$$

$$\text{the } F\left(\frac{dy}{dt}\right) \text{ ratio} = r\left(\frac{d_2}{d_1}\right)^2$$

$$\text{Hence } B \text{ Ratio} \times (Y-Y_0)^{3/2} \text{ ratio} = r\left(\frac{d_2}{d_1}\right)^2$$

$$\text{or, } B \text{ ratio } \times q^{3/2} r^3 = r\left(\frac{d_2}{d_1}\right)^2$$

$$\text{or } B \text{ ratio} = \left(\frac{d_2}{d_1}\right)^2 \frac{1}{q^{3/2} r^2} = \left(\frac{d_2}{d_1}\right)^2 \frac{1}{y \text{ ratio} \sqrt{q}} \quad (28)$$

The quantity of water discharged over the weir edge will be given by an expression of the form

$$v = KB\int (Y-Y_0)^{3/2}\,dt \quad \text{----------(29)}$$

Here as before we assume the general factor K the same for all cases involved. Then we have

$$B \text{ ratio} = \left(\frac{d_2}{d_1}\right)^2 \frac{1}{q^{3/2} r^2}$$

$$(Y-Y_0)^{3/2} \text{ ratio} = q^{3/2} r^2$$

$$dt \text{ ratio} = \frac{p}{qr}$$

Hence

$$\text{Volume ratio} = \frac{p}{q}\left(\frac{d_2}{d_1}\right)^2 = \frac{p}{q}\,\frac{A_2}{A_1} \quad \text{-----(30)}$$

which is the same as the volume ratio for other parts of the chamber as derived in (22).*

Some illustrations may now be given

*For the case of Johnson's differential regulator (*Trans.* Am. Soc. Mech. Eng., Vol. 30, p. 457) the same fundamental equations apply as for the plain open chamber (equations (3) to (6)), except that y is to be considered as a constant, y_m = the maximum value of y. Under these conditions the ratios and relations will be the same as for the plain chamber, and the performance in detail may readily be investigated by means of the model form.

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of the method of using these various relation ratios. Suppose in a given case we have $L_1 = 5000$ ft., $b_1 = 0.45$, $d_1 = 3$ ft., and suppose that with a surge chamber 10 ft. in diameter and a change of velocity from 7 ft. per second to 4 ft. per second the time of the first surge is 1.7 minutes and the extent of the movement of the water-level is 20.1 ft. while the change for final conditions is 14.85 ft., thus showing a first surge beyond final steady conditions of 5.25 feet.

Next suppose a proposed case as follows: $L_2 = 8000$ ft., $b_2 = 0.48$, $d_2 = 4.5$ ft., with lower velocity $v_2 = 5$ ft. per second. Then the fundamental relations between the two cases are

$$L \text{ ratio} = p = 8000 \div 5000 = 1.6$$
$$b \text{ " } = q = 0.48 \div 0.45 = 1.067$$
$$v \text{ " } = r = 5 \div 4 = 1.25$$

Then upper velocity in second case for corresponding conditions will be

$$V_2 = 7 \times 1.25 = 8.75$$

$$\text{Vertical ratio} = qr^2 = 1.667$$

$$\text{Time ratio} = p \div qr = 1.2$$

$$\text{Diam. Ratio} = \frac{\sqrt{p}}{qr}\left(\frac{d_2}{d_1}\right) = 1.423$$

Hence in the proposed case with a similar acceleration history and with a corresponding change in the velocity from 8.75 ft. per second to 5.0 ft. per second, the time for the first surge will be 1.7 multiplied by $1.2 = 2.04$ minutes. The surge chamber diameter must be 10 by $1.423 = 14.23$ ft., the total extent of the first movement will be 20.1 ft. by $1.667 = 33.5$ ft., while the change for final steady conditions will be 14.85 by $1.667 = 24.75$, and the extent of the first surge beyond the level for steady conditions will be 5.25 multiplied by $1.667 = 8.75$ ft. The principal significance of these relations seems to lie, however, in the possibility of the investigation of surge-chamber problems by means of model experiments made on relatively small or laboratory scale. Thus for every actual or field problem there may be made up a model for which the following ratios and relations will result.

The length ratio p and the diameter ratio d_2/d_1 will result from the dimensions proposed. The velocity ratio r will result from the upper velocity which it may be convenient to develop in connection with the model.

The velocity-friction head ratio q will result from a comparison of the proposed value of b in equations (3) or (5) for the given case with the actual value of b for the model, determined by a series of measurements of velocity and velocity-friction head.

The time ratios and the surge chamber diameters D_2/D_1 will then result from (17) and (21).

These operations will be made clear by an illustrative problem taken from certain model studies made in connection with the surge chamber at the San Francisquito plant No. 1 on the line of the Los Angeles aqueduct.

The field case somewhat simplified may be represented as follows:

Length of conduit, feet	41,000
Diameter of conduit (equivalent circular), feet	11.3
Area of conduit, square feet	100
Upper velocity, feet per second	10
Friction-velocity head at 10 ft-sec., feet	76
Friction-velocity head coefficient	0.76

Proposed form and dimensions of surge chamber as shown in Fig. 3a.

Suppose now that it be desired to investigate the behavior of this case by means of a model involving for the conduit some 13.6 ft. of 1-in. piping.

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We have then as follows:
Length ratio $p = 41{,}000/13.6 = 3015$
Diam. ratio $d_2/d_1 = 135.6/1.05\dagger = 129.1$

Suppose it be found by investigation that an upper velocity of 3.76 ft. per second will be most suitable and convenient for the model. Then velocity ratio $r = 2.66$.

Next let a series of measurements be made for the model value of the velocity-friction head coefficient b. This will require simply simultaneous measurements of time, volume discharged and velocity-friction head. The two former with the known cross-section of the pipe will determine the velocity, and this with the observed loss of head will serve to determine b for the model. Suppose in this way that the value is found $b = 0.1214$. Then we have for the b ratio $q = 0.76 \div 0.1214 = 6.26$.

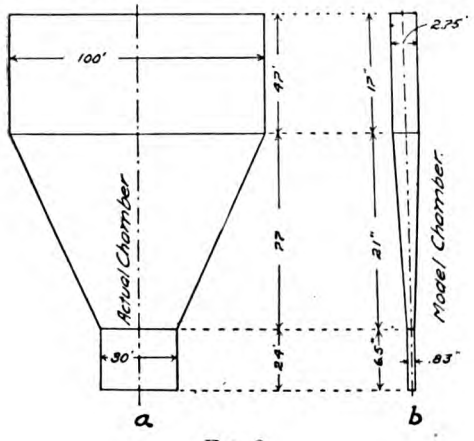

FIG. 3.

We then have as follows:

From (17) the time ratio $s = 181$.

From (13) the vertical or Y ratio = 44.33.

From (21) the ratio $D_2/D_1 = 436$.

Suppose that we then proceed to build the model chamber in accordance with these dimensions as in Fig. 3b. It will be noted that the proportions of the model are entirely different from those of the actual case, the horizontal ratio being much greater than the vertical.

The model being completed and set up ready for use, suppose that it be desired to investigate by its means the behavior of the actual case under a sudden rejected load requiring a reduction in the velocity along the main conduit from 10 ft. per second to 4 ft. per second.

The corresponding velocities for the model are 3.76 and 1.504 ft. per second, which by a suitable calibration may be readily expressed in terms of opening on the control valve or in terms of velocity-friction head. With steady flow in the model at the valve setting corresponding to a velocity of 3.76 ft. per second, the valve is suddenly closed to the setting corresponding to a velocity of 1.504 ft. per second. With any convenient or suitable means of measuring or recording the vertical movement of the water and time we may suppose the following results observed:

Maximum movement of water on first up surge, inches.....18.05
Ultimate level of water above original level, inches 17.75
Difference representing surging movement beyond level for steady conditions, inch..... 0.30
Time of first up surge, seconds.. 12

The ratios for vertical movement and for time are respectively $qr^2 = 44.33$ and $p/qr = 181$, and hence we shall have in the actual case for the sudden reduction of the velocity from 10 ft-sec. to 4 ft-sec. as follows:

Maximum movement of water in first up surge, feet.....66.69
Ultimate level of water above original, feet 65.58
Difference representing surging movement beyond level for

†Actual internal diameter.

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steady conditions, feet..... 1.11
Time of first up surge, minutes...36.20

Suppose similar observations made under demanded load conditions requiring the sudden increase of velocity from 4 to 10 ft. per second for the field case or from 1.504 to 3.76 on the model.

Let the results be as follows:

Maximum drop of water on first down surge, inches.....17.75
Final drop of water below original level, inches 17.75
Difference 0.00
Time of drop, seconds..... 20

With the same ratios as before, we should then conclude that the total drop of water would be 65.58 ft., without periodic surging, and that it would gradually approach this level as an asymptote, sensibly reaching such condition in a time of 60 minutes or 1 hour, assuming, of course, that during this period the conditions remain sensibly steady at the velocity of 10 ft. per second.

It may be here noted that, strictly speaking, a somewhat special form of discharge valve will be required if the rate of discharge is to be maintained constant under the variable head which will exist during the transition period. Thus in the case of rejected load, if the valve is suddenly closed down, the first discharge will be under the effective head corresponding to the high velocity, while during the transition period with decreasing velocity the effective head will increase correspondingly to that ultimately due to the final reduced velocity. With a fixed valve opening, therefore, the rate of discharge will increase with decreasing velocity and rising level of water in the surge chamber. In the apparatus devised by the author this variation may be compensated for by a compound valve opening mechanism comprising the following elements:

1. A quick opening device with stop which may be adjusted at will corresponding to any desired rate of discharge under any effective head.

2. A cam or slow motion device which is operated by the hand following with a pointer the level of water in the surge chamber as it rises or falls, and so connected that the resultant cam movement adjusts the valve opening to such degree as to compensate for the varying effective head at the valve. In operation, then, for the case of rejected load the stop would be set for the opening of the valve corresponding to the proper final discharge rate under the relatively low effective head at the higher velocity v_1. The first sudden closure of the valve would then be to this stop. Then, as the water-level in the chamber rises and the effective head increases, the corresponding movement of the cam will be such as to further close the valve, thus maintaining substantial uniformity in discharge rate until the water reaches steady conditions with velocity v_2.

It may be noted that observations with and without the cam in operation do not indicate any serious error by its omission, at least for the problems most likely to arise.

As a further illustration, take the case of a spillway for the above proposed chamber 30 ft. wide and at a level of 1 ft. above static level. Suppose it be desired to find the depth to which the water will rise on the edge of the spillway in the extreme case of a sudden closure from a velocity of 10 ft-sec. to zero.

The ratio for spillway width as noted in (28) will be 158.7, and the volume ratio as in (30) will be 8,027,000.

The spillway on the model will therefore have a width of 2.27 in. and the edge will be 0.27 in. above static level.

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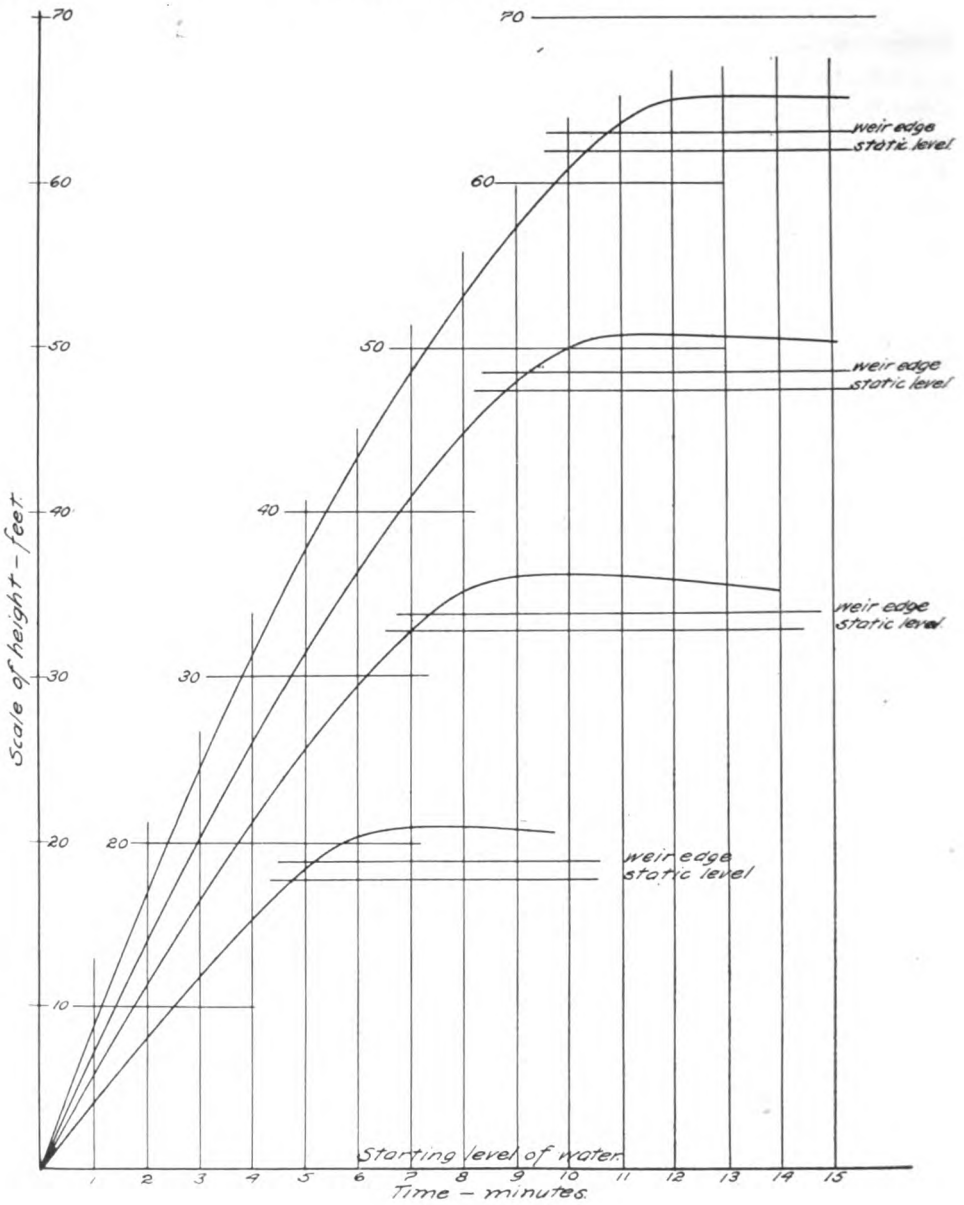

FIG. 4.

Let the experiment be carried out on the model and suppose the maximum observed depth of water on the edge to be 0.52 in., the time to the attainment of this depth to be 5 seconds, and the total volume of overflow to be 23.5 cu. in. Then for the actual case we may anticipate the following results:

Maximum depth of water on spillway, inches	23.5
Time to attainment of maximum depth, minutes	15.1
Volume of overflow, cu. ft	109,150

In Fig. 4 are shown to reduced scale typical diagrams autographically traced by the model apparatus, but with scale units translated into full-size values,

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and corresponding to complete closures from original velocities as noted. A complete series of such experiments gives the results for maximum rise of water as shown in Fig. 5. It will be noted that there is but slight difference in the maximum depth for varying values of the velocity varying between 10 ft-sec. and 3 or 4 ft-sec. The physical explanation is readily seen to be due to the fact that while with decreasing initial velocity there is less velocity and energy to quench, there is also less vertical space and less volume in which to effect such quenching, and hence there is a tendency for the water to rise to nearly a uniform depth on the edge of the overflow, irrespective of the initial values.

Many other problems may be studied with equal readiness, and in fact there is perhaps no problem involving the hydraulic characteristics of operation of a pipe-line which may not be to advantage thus investigated by means of model experiments connected with the actual case through the ratios and relations which have been developed in the present article.

In particular it may be pointed out that the model method is quite as readily applicable to a tapering or irregular form of surge chamber as to cylindrical form. It is only necessary that the model be geometrically similar to the proposed form of chamber through the relation ratios for vertical dimensions and horizontal section areas as given in (13) and (20) respectively.

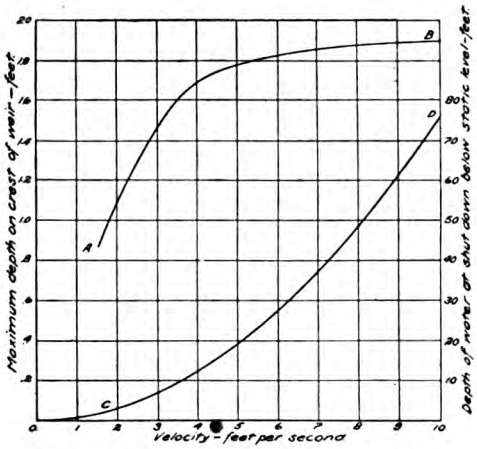

FIG. 5. CURVE AB REFERS TO VELOCITY AND LEFT-HAND SCALE. CURVE CD REFERS TO VELOCITY AND RIGHT-HAND SCALE.

Reclamation Work of the Netherlands Farms Company, Yolo Basin, California

By FRED H. TIBBETTS*

THE Netherlands Farms Co. is reclaiming the remaining overflow land in Yolo basin below Sacramento and east of the by-pass. Yolo basin is the lowest and one of the largest of the great flood basins bordering the Sacramento river. Along all of these basins the river has a characteristic elevation of banks with depressed basins, or shallow troughs on either side, which is generally found with large rivers heavily laden with silt. The slope of the ground is generally rapid from the vicinity of the river toward the axis of the trough, which is from 2 to 7 miles distant, and depressed

*Of Haviland, Dozier & Tibbetts, Consulting Engineers, San Francisco, California.

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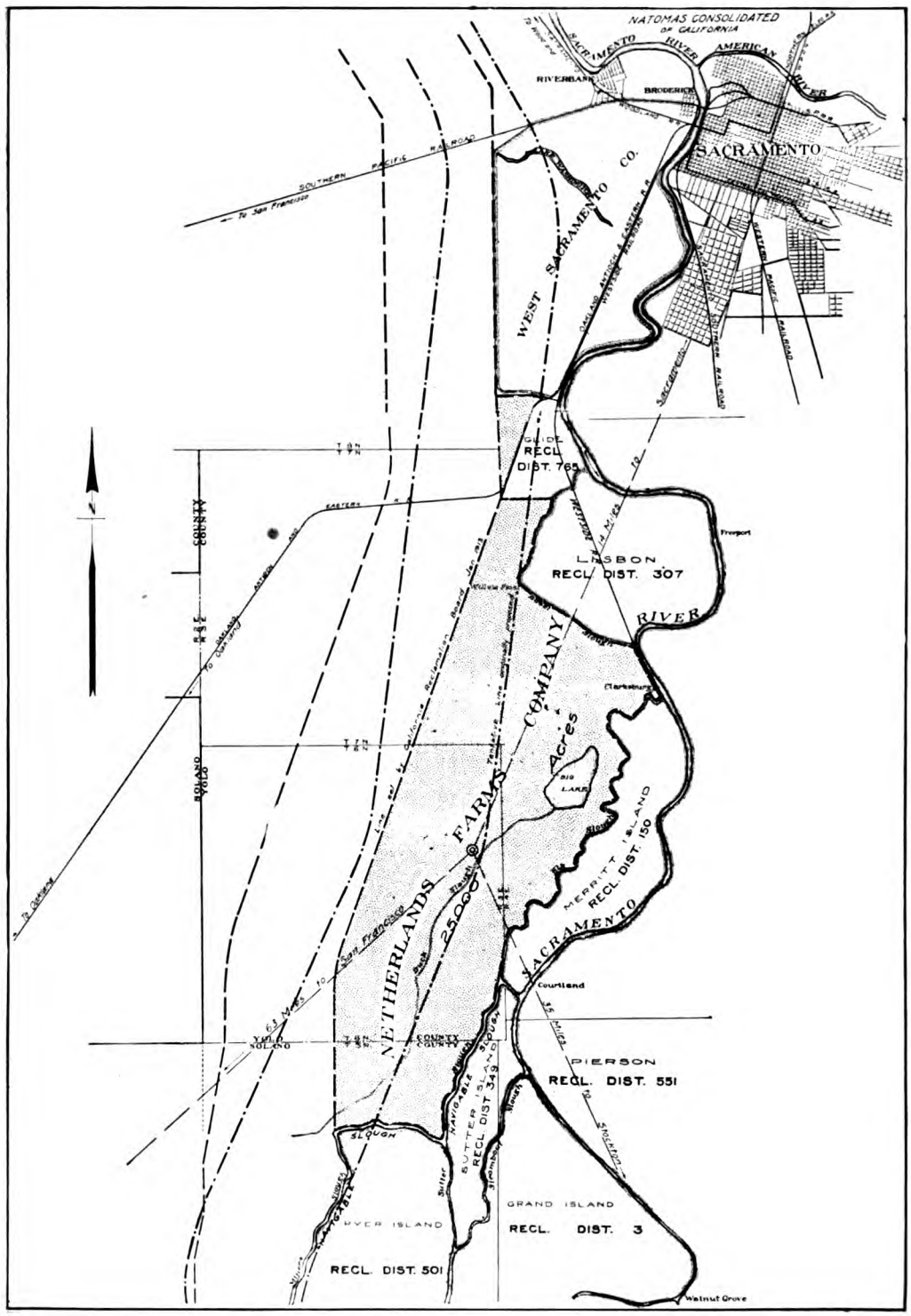

MAP OF NETHERLANDS FARMS CO., YOLO AND SOLANO COUNTIES, CALIFORNIA.

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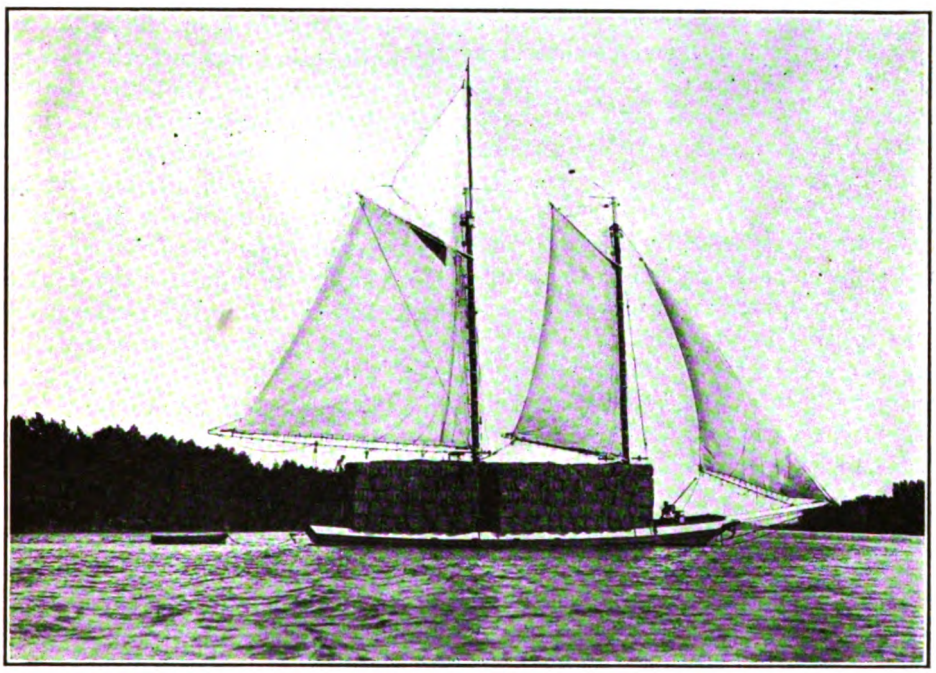
6 to 12 ft. below the river banks. The Sacramento river borders the eastern edge of Yolo basin for about 75 miles. Along the eastern edge of the basin are a number of reclamation districts extending from the river a distance of 2 to 4 miles toward the trough of the basin. The mouth of the Feather river, the principal tributary to the Sacramento, is near the upper end of the basin, and near its centre is the mouth of the American river, another large tributary, and the city of Sacramento. From the Feather river to the lower end of Yolo basin, the Sacramento river is incapable of carrying more than a fifth of the flood water passing down the valley. The balance under the present general plan of flood control in the Sacramento valley must pass through Yolo basin in a large by-pass over 2 miles in width, the eastern edge of which is now situated at an average distance of 3 to 4 miles west of the river. For about 10 miles either side of Sacramento the land between this by-pass and the river has been reclaimed. The remaining land at the south end of the by-pass forms the Netherlands Reclamation district containing nearly 30,000 acres.

At the time the Netherlands project was first conceived, the preliminary location of the by-pass was in the trough or lowest part of Yolo basin. This left a tract of not over 13,000 acres, too small to profitably reclaim. After a careful preliminary study of the problem, the conclusion was reached that if sufficient data were available this location would be shifted much farther westward so as to leave a much larger tract capable of economic reclamation. With this end in view an extensive preliminary survey was organized early in 1912. The result of this



NAVIGABLE WATER ADJACENT TO NETHERLANDS PROJECT.

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survey was a topographic map on a scale 1 in. to 1000 ft., with 1-ft. contours over practically the whole of Yolo basin south of the Southern Pacific railway track, a total area of over 100,000 acres. This work was prosecuted under extremely difficult conditions, as much of the land was covered with water, and with an exceedingly dense growth of high tules. A traverse was chained around the outer edge of the tract surveyed with one cross-line near the centre, and the whole carefully checked and balanced. Profiles were then run across on east and west lines at 1-mile intervals. From these profiles stadia topography was taken generally by direct leveling with the transit measuring distances by stadia and angles by compass. In some cases 'tule wagons' were fixed with elevated platforms resting on the axles upon which transits could be set up high enough to overlook the tule. These were used in conjunction with rodmen mounted on horseback with 14-ft. stadia rods. The work was greatly retarded by the lack of transportation for surveying parties. The intense heat was also a difficult feature. To facilitate the work, a large house boat was purchased and fully equipped for headquarters for the surveying parties. Two gasoline launches and a number of smaller boats were used. The 1-ft. contour map is sufficiently accurate to serve as a basis for the location of levees, canals, drainage ditches, and roads. Profiles compiled from this map are sufficiently accurate for location and construction purposes.

The principles governing the proper location of the Yolo basin by-pass were thoroughly studied by the consulting engineers of the State Reclamation Board, Major S. A. Cheney, of the California Débris Commission; W. F. McClure, State Engineer, and his assistant, E. A. Bailey, Flood Control Engineer. In general, the preliminary location of the channels was first established in the deepest portions of the flood basins with little reference to existing or probable improvements, or to the character of the land occupied. The by-passes are essentially large canals for the conveyance of water from one portion of the valley to portions lower down. Following conventional engineering practice, such canals are not usually located on a direct alignment from one end of a valley to the other, but rather follow grade contours in order that the slope and velocity may be uniform and the tendency to silt reduced to a minimum. With the low velocities obtained in the by-passes it seems inevitable that slow silting will occur. Experience with the Elk Horn weir indicates the danger of sand and silt being thrown up over the sill of the easements proposed in the Yolo basin. The Yolo basin by-pass as finally located follows around the outer or western rim of the basin. The outer or western levee is thus located on high ground, and becomes much the smaller. In places the by-pass is so close to the western rim of the basin that it protects only a narrow margin of land so high that it will be flooded only for occasional brief periods during the few years that the by-passes reach their maximum discharge. In such cases it may be found advisable to omit the outer levee, and recompense the owners of adjacent land for the nominal damage caused by occasional flooding of their land for brief periods.

In the lower portion of Yolo basin there is a rank growth of tules from 3 to 7 ft. high, while toward the margin of the basin there is nothing but a sparse growth of very short grass. At the latitude of the Netherlands project the trough of Yolo basin is only a few feet above tide level, so that it is usually impractical to burn the tules ex-

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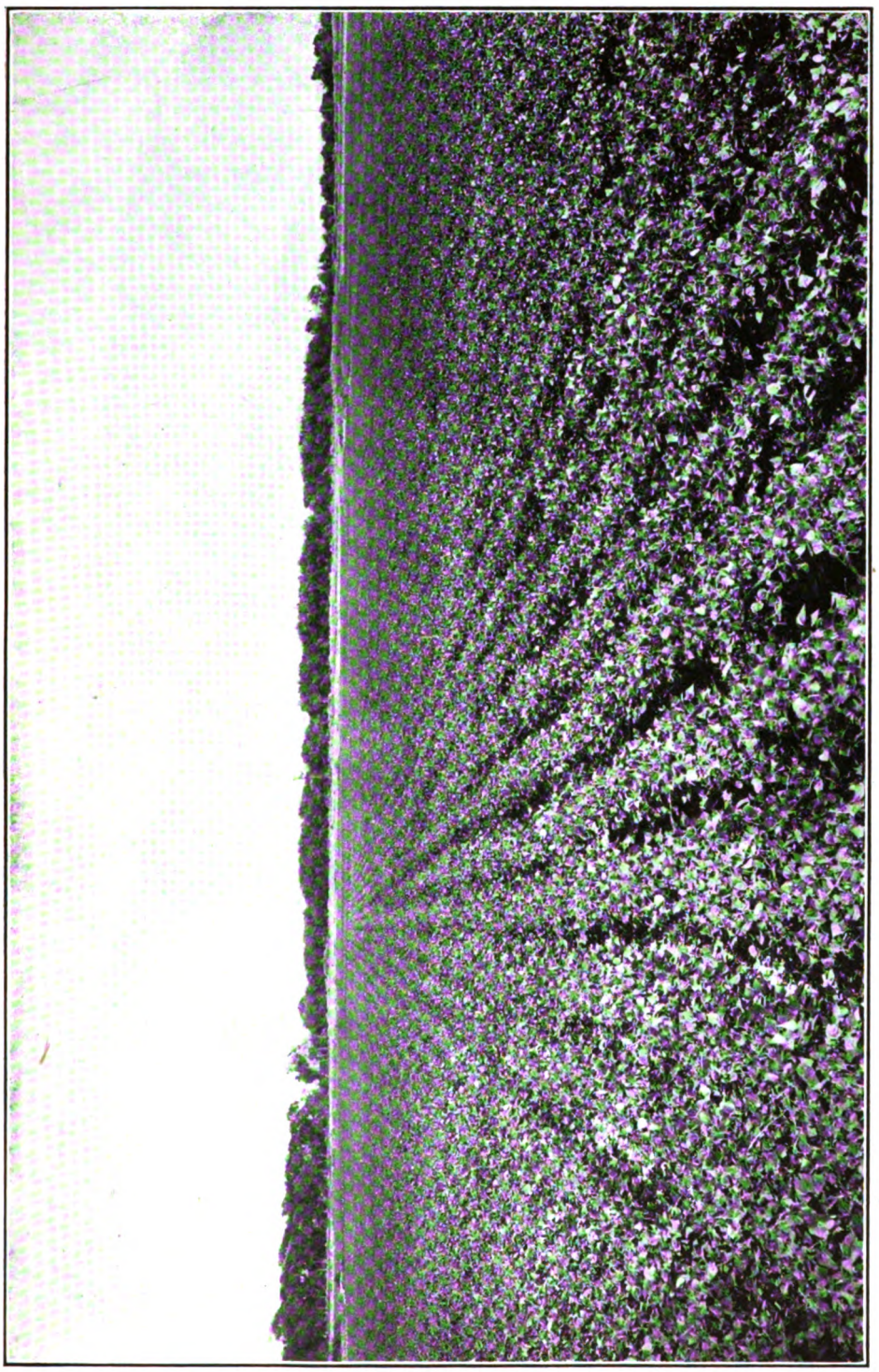

CROP OF BEANS IN CENTRAL PORTION OF NETHERLANDS PROJECT.

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cept in alternate years when the dead growth of the preceding year is matted close to the ground. Even if burned, the green tule shoots may grow high enough in January and February to seriously obstruct the passage of floods in March. Wherever such tule growth exists, it is equivalent so far as water carrying capacity is concerned to raising the floor of the by-pass to the approximate height of the top of the tules.

The value of the land sacrificed in the Yolo by-pass is exceedingly important. In general the better land is found on the riverward side of the trough, being built up by overflow from the river and sloughs. An exhaustive study was made by the state engineer's office founded on detailed soil analysis, to place the by-pass on the least valuable land which was found to be toward the western rim. The original and final location of the Yolo basin by-pass forming the western edge of the Netherlands reclamation are shown in the accompanying map.

The land proposed to be reclaimed by the Netherlands Farm Co. occupies all of the balance of the unreclaimed land in Yolo basin, south of Sacramento, and east of the Yolo basin by-pass. It extends for a distance of about 15 miles in a north and south direction, from the lower end of district No. 900 (West Sacramento Co.) to the upper or northern end of Ryer island. At the north end of the project are two relatively small areas, one west of the Glide district, and one west of the Lisbon district. The bulk of the land is between the Lisbon district and Ryer island, and consists of a large regularly shaped tract containing over 24,000 acres, with a length in a north and south direction of about 11 miles, and a width in an east and west direction varying from about 2 miles in the southern end to 4 miles in the northern end, and averaging about 3 miles. This portion of the total tract, containing between 24,000 and 25,000 acres, and lying south of Willow point and the Lisbon district, forms a separate unit for reclamation purposes, and will be entirely surrounded by an independent levee system.

The centre of the tract is about 14 miles south of Sacramento, 35 miles northwest of Stockton, and 63 miles northeast of San Francisco. It has a frontage of about 1¼ miles on the Sacramento river, at the upper end, including the town of Clarksburg, and at the lower end it has a frontage of about 5⅔ miles on Sutter and Miner sloughs, both of which are deep, navigable branches of the Sacramento river delta.

Topography

The head of the Sacramento delta was formerly at the northeast corner of the tract under discussion. The entire east side of the tract is bordered by the Sacramento river and by former delta branches, namely, Elk slough and Sutter slough. The south side is similarly bordered by Miner slough. Overflow from the banks of the river and from these sloughs has built up a margin of land about 6 to 7 ft. higher than the average level opposite. The land on this margin, however, slopes rapidly away from the river and sloughs, reaching the normal level of the basin in a distance of 1000 to 2000 ft. With the exception of this marginal strip of high land, the tract is remarkably level, with a barely perceptible slope not over 1 to 3 ft. from north to south. General ground elevations along the marginal fringe on the east and south sides vary from 7 to 14 ft. above low tide (U. S. E. D. Datum). The balance of the land, comprising probably 90% of the total, is at an elevation of from 5 to 7 ft. At

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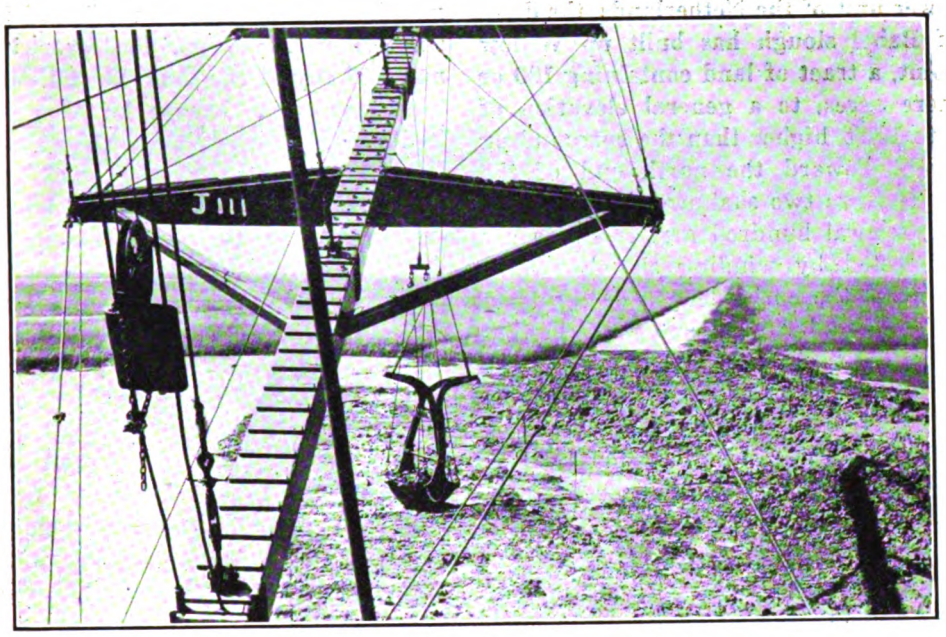
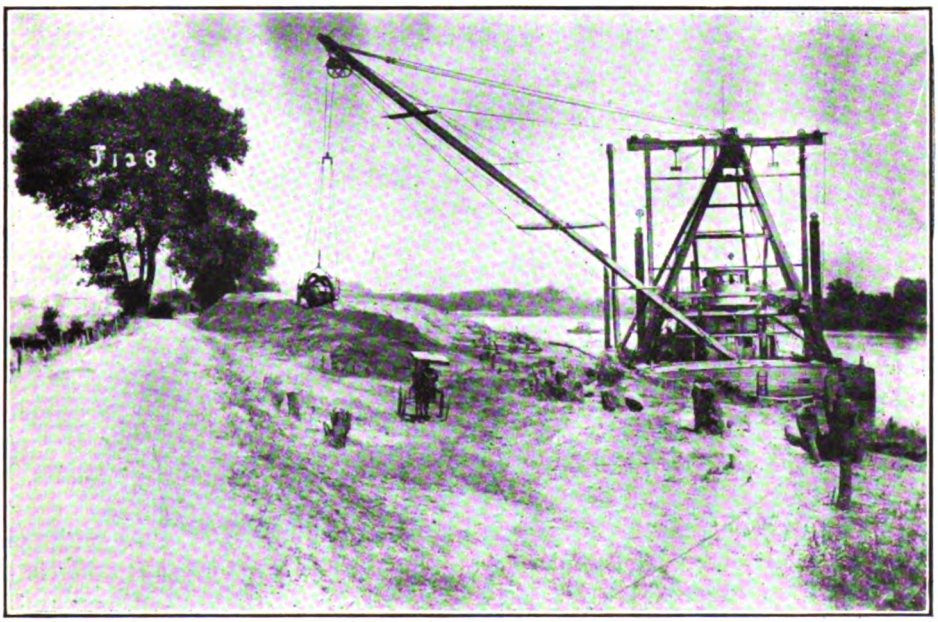


DREDGING FIRST CUT, ROUNDING TURN AT END OF SECTION 3.



DREDGE ON KNOX PLACE; RIVER LEVEE WITHIN ABOUT 4 FT. OF GRADE.

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the extreme northwest corner of the lower unit of the Netherlands, the delta of Babel slough has built up Willow point, a tract of land containing 100 or more acres, to a general elevation of 2 to 10 ft. higher than the surrounding land. Toward the north end of the project are two shallow lakes, containing several hundred acres. These are connected by winding sloughs which traverse the entire length of the tract in an irregular alignment near the centre. These sloughs have been dug out at various times to permit the passage of dredges engaged on reclamation work in Yolo basin. The sloughs have numerous short winding branches continued in broad shallow depressions, 1 to 3 ft. in depth, which are quite numerous in nearly all portions of the tract. The main slough down which the dredges have worked is 40 ft. or more in width, with a low tide depth of 3 to 10 feet.

In its natural state, nearly all of the tract is covered with a heavy growth of tules, except for a narrow fringe of willows and cottonwoods, and underbrush on the high marginal land along the sloughs, and for some groves of large oaks near the north end.

Flood Conditions

Owing to the limited capacity of the Sacramento river, in extreme floods over 80% of the water coming down the valley must pass through Yolo basin. Under normal conditions the entire Netherlands tract is annually inundated during winter and spring floods, to a depth in places during severe floods, as great as 15 ft., though it is only in flood years that the high marginal land is flooded. As the Netherlands is near the extreme lower end of the flood plane of the Sacramento valley, the flood water drains off slowly and the lower portions of the tract are usually submerged for a number of months each season and until well into the summer. No use has ever been made of any of the land beyond occasional pasturage, except for very limited areas of high land, close to the sloughs, and near the upper end.

During the proceedings incident to securing from the State Reclamation Board permits for the levee construction desired by the Netherlands Farms Co., the location of the lower end of Yolo basin by-pass was definitely fixed and the extreme high water marks were determined within narrow limits. It is hence possible to predict with much certainty the maximum future flood heights at all points surrounding the proposed reclamation. The widths of the by-pass are not definitely fixed, but no probable change can make more than 1 ft. difference in the high water marks at any point adjacent to the Netherlands.

At present, flood conditions in lower Yolo basin are greatly aggravated by the narrow, restricted outlet of the Sacramento river from its mouth to Cache slough at the outlet of Yolo basin. Joint work is now under way by the State and the California Débris Commission, which will widen with large suction dredges the restricted sections. This work, which should progress rapidly, will afford much relief to flood conditions around the Netherlands.

Between the lower unit of the Netherlands and the Sacramento river, except for a distance of 1¼ miles at the upper end, are the excellent reclamations of Merritt, Sutter, Grand, and Ryer islands. The levee systems of these old reclaimed districts afford to the Netherlands a large amount of protection from the flood wave in the Sacramento river. Although their levees are lower and of more slender cross-section than those

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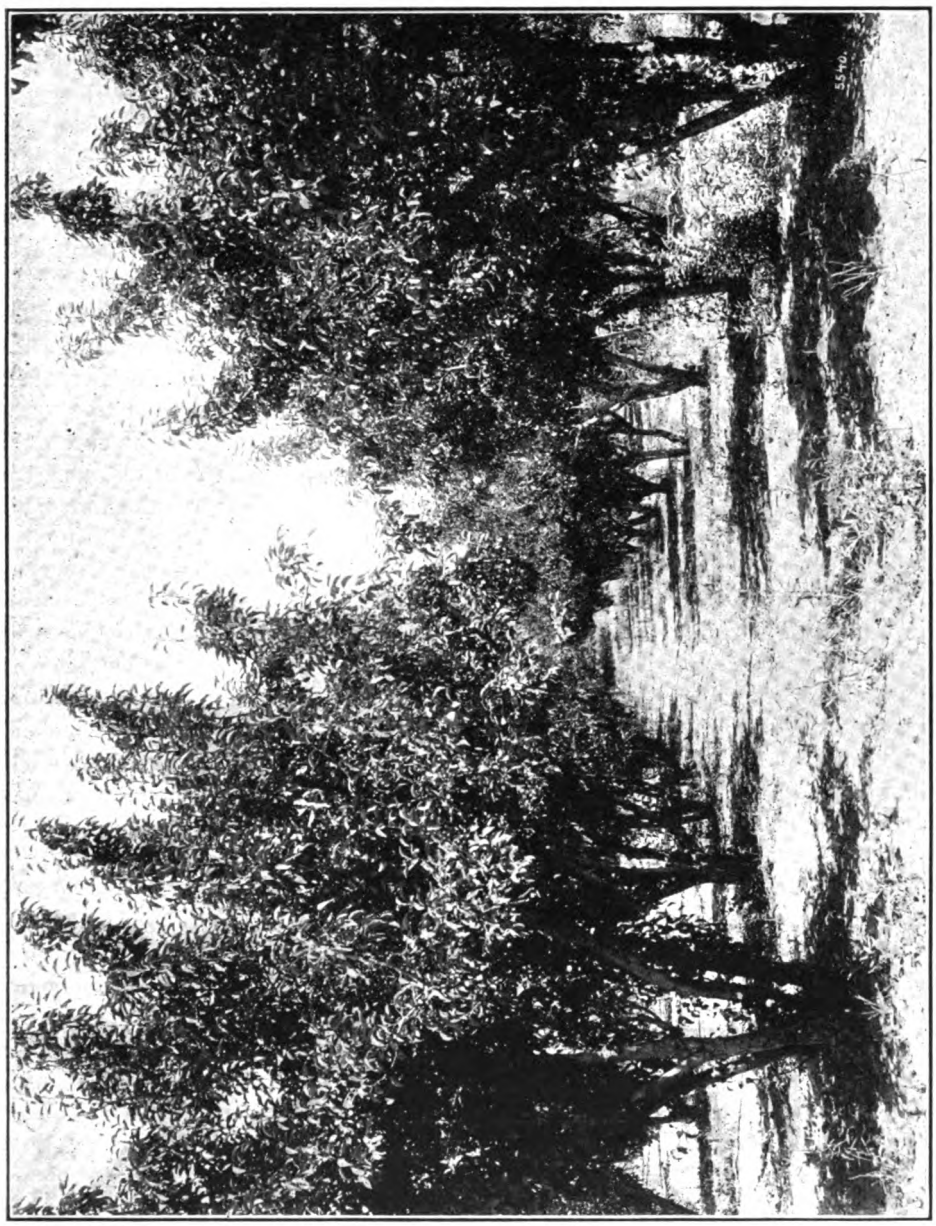
being built for the Netherlands, they have proved among the best reclamations in the Sacramento valley. The first three, especially, have not been in-

lands Farms Company's project.

Proposed Levee System

It is proposed to secure protection



PEAR ORCHARD ON THE PETERSON PLACE NEAR SOUTH END OF NETHERLANDS PROJECT.

undated for many years. It is possible that the back levee of Merritt island can be strengthened and used for a portion of the east levee of the Nether-

from flood waters for the lower unit of the Netherlands by entirely surrounding it with an unbroken and massive system. Seepage and drainage water

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will then be controlled by means of drainage canals and laterals, and by a large pumping plant at the lower corner of the district. The proposed levee system consists of 31⅓ miles of levees, with a total volume of approximately 8,000,000 cu. yd. In order that the district may be certainly protected in the event of the failure of levees of adjacent reclamations, it is proposed to provide at the north end a continuous cross-levee, including the south levee of the Lisbon district, from the Sacramento river to the Yolo basin by-pass. This levee will be built to such a height that it will afford ample protection under any possible conditions of levee failure on the river to the north. If the back levee of Merritt island is utilized for a portion of the east levee of the Netherlands, the same precaution will be observed.

The grades on all levees are fixed at least 6 ft. above the maximum estimated high water marks. This requirement, which is unusually conservative, is provided on the back levees, because of the possible exposure to wave wash, and on the river and slough levees, because of some uncertainty regarding the exact maximum height of the flood plane under conditions liable to develop during the construction of the Débris Commission project for flood control. The west, or back levee, especially, is being built more massive and larger than any, of which the writer has knowledge, constructed for similar purposes. The levees along the sloughs also have heavy cross-sections, but as they are situated on higher ground they are not so large. The actual and final estimated high water marks are but little higher at points on the river and sloughs than at points in the basin opposite, and hence actual elevations of the crests of the levees along the front and rear of the project are not greatly different.

The ground to be occupied by the levees, except where it is impracticable to do so on account of water, will be thoroughly cleared and plowed, and where it is now occupied by trees or brush, will have the stumps pulled and grubbed. This precaution will insure a continuous bond between the levee base and its foundation and will reduce seepage to a minimum. All levees, except the river levee, will have at their axes a muck ditch, dug into the original ground surface, at least 6 ft. in depth in order that all lines of weakness in the foundation of the levees may be intercepted, the seepage reduced, and the levee firmly keyed to the natural ground surface. In the case of the back levee, the muck ditch has been dug with small ditchers, and in the case of the slough levees it will be dug with traction ditchers or teams. A berm of undisturbed material at the natural ground surface at least 30 ft. in width is provided in all cases between the outer toe of the levee and the inner edge of the borrow pit. This checks sloughing of the outer surface of the levee and prevents the concentration of destructive currents along the levee. It also prevents caving of the banks of the borrow pit from reaching the levee section. All levees are being constructed with large clam-shell dredges from material obtained from borrow pits or canals paralleling the levees. The levees are being carefully built up in layers in order that there may be no undue settlement or sloughing of material outside of the desired cross-section. The Willow Point cross-levee and the back levee where there is a possibility of exposure to wave wash will be protected by a heavy growth of willows, planted on the outer slope of the levees and on the opposite side of the borrow pits. Protection from wave

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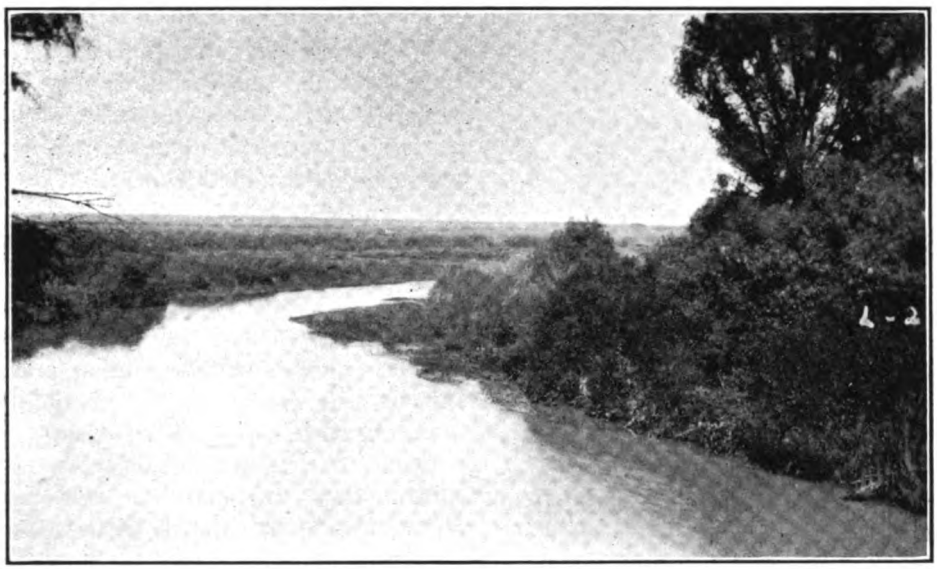
wash will be secured by planting the outer slope with willows or swamp cypress at the corners of 5 ft. squares. In addition to this protection, a break water mound is to be provided, 4 ft. in height, with a 6-ft. top width, and 1 on 3 side slopes. On this mound are to be planted four rows of willows or swamp cypress. Experience has shown that willows will grow rapidly on a mound elevated as much as this above the general surface of the overflow land. Willows and brush for breaking waves are more efficient, if situated some distance, in this case over 200 ft. from the slope. The deep borrow pit will tend to concentrate the water so that it will have a swift and distinct current, parallel to the levee, sufficient to be quite effective in breaking waves, but not sufficient to endanger the levee from erosion. The river levees where required will be protected from steamer wash and direct current scour by standard pile and brush protection.

Estimates of cost have been prepared according to the tabulation following.



LOOKING NORTHWARD UP DUCK SLOUGH ABOUT 2½ MILES WEST OF COURTLAND.

Cost Estimates

The cost estimates are based on the following unit prices:

Levee construction:

River levees, 6c per cu. yd.
Slough levees, 7c per cu. yd.
Back levee, 8c per cu. yd.
Muck ditch, 25c per cu. yd.
Clearing, $70 per acre.
Plowing, $10 per acre.
Planting willows, 5c each.

Piling and brush bank protection, $2.75 per lin. ft.

The above costs are exclusive of engineering or administration, but 10% is added for incidentals. On this basis the total estimated cost for levee work on the lower unit of 24,337.8 acres, is $738,860 or about $31.50 per net acre.

The total cost including the foregoing expenditures: drainage, purchase price of land, interest during construction, and for improvements necessary to reclaim the land completely and in a shape to market, is estimated at approximately $100 per acre.

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Drainage

Detailed plans for drainage of this tract have not as yet been completed. The essential feature, however, would be the utilization and enlargement of the large slough now extending longitudinally through the centre of the tract. Drainage laterals at ½-mile intervals will conduct seepage and rain water to this main canal. At the lower end, and near the southwest corner of the project, a pumping plant will be erected with a capacity of about 200,000 gallons per minute. This will consist of four equal units of 42-in. centrifugal pumps direct connected to horizontal two-speed electric motors. They will pump water through the levees into the by-pass. The plant will be arranged so that water can be siphoned into the district in the reverse direction if desired. A part of the drainage system control gates will also be placed which will make it possible to admit water from the river near the upper end of the project, or from Miner slough, near the lower end of the project. At the lower end tide gates will also be installed to permit of the automatic lowering of the water-level in the main drainage canal to the level of low tide. It is estimated that the drainage work will cost about $10 per acre.

Subdivision

The entire tract will be subdivided into small farms of approximately 10 to 40 acres in size. It is probable that three townsites will be laid out, one on the river at the northeast corner of the project, one on the eastern edge of the project near the centre and about ½ mile from the river with which it will be connected by the deep navigable channel of Sutter slough, and one at the southeast corner of the project at the junction of Miner and Sutter sloughs, both of which are navigable. The West Side Electric railroad will extend longitudinally through the project near the centre, and provide quick transportation for each of the townsites, and for the entire district. A very careful study has been made of the subdivision in order that main diagonal roads may be laid out so as to give quick and direct transportation from every farm to the nearest townsite.

Time of Completion

The permit of the State Reclamation Board granted permission for the construction of the Netherlands levees and contains a limitation that the levees be not closed prior to the spring of 1914. It should be possible to close the levees promptly at the expiration of the date set, and to a height sufficient to afford protection during any normal flood for the winter of 1914 or 1915. The time of final completion will depend upon the rate of progress which it is possible to maintain on the heavy back levee.

From four to six dredges are now continuously engaged on the back levee. The muck ditch is entirely complete, portions of it on high ground having been constructed by road excavators, but the most of it by small clam-shell ditching machines. As the cross-section of the main levee is unusually high and massive, it cannot be forced too fast without having material slide outside of the cross-section, increasing the bulk of the levee beyond the estimated amount, and making it difficult to raise it to grade. As the slough levees are of more moderate size, and the borrow pits are all at tide water level, and readily accessible to the Sacramento river, construction work can progress at any time, and with any number of dredges found most convenient. It should be possible to close the back levees above high water

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marks during the fall of 1914, and to hold the levees against any probable floods with the aid of the large dredges which will be working during the winter of 1914-1915. It will be easy to keep other features of development at a more advanced stage, so that the property should be available for disposal in the spring of 1915, and might be available for disposal but hardly for settlement in the summer of 1914.

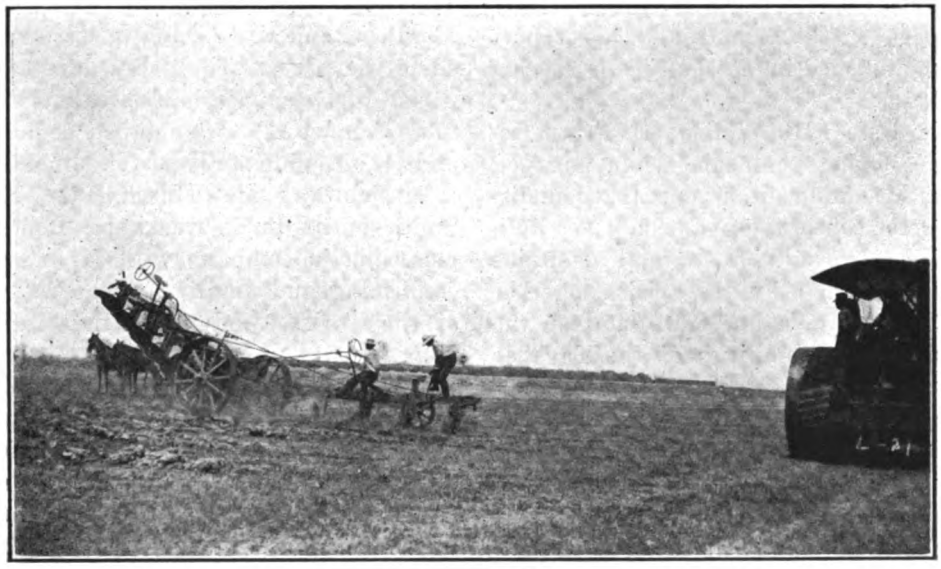
Soil

The soil of the Netherlands Farms Co. has been formed largely by material carried in suspension by the flood waters of the Sacramento river and deposited for many years past. The texture of the greater portion of the soil is clay loam, mixed with fine sand and humus. The soil in the eastern half of the tract is strictly what is known as 'general purpose soil,' as in this half the alluvial sediment and tule decay is deeper. At present the top layer of the soil stratification consists of a soft tule mud with an average thickness of about 5 to 12 feet. Underlying this is a blue clay, and deeper, a yellow clay stratum. This class of land has been successfully reclaimed and after being cultivated and thoroughly aerated has proved to be of a most highly productive type.

Lands in adjoining reclaimed districts are in a state of high cultivation, and sell at prices ranging between $300 and $400 per acre, depending on location and state of cultivation.

Management

The working out of this project is under the direction of the same experienced interests which have successfully reclaimed the West Sacramento and other properties, while the financing has been provided by Louis Sloss & Company.



BREAKING LAND WITH STEAM PLOWS BETWEEN UPPER END OF LAKE WASHINGTON AND THE RIVER.

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Petroleum Resources, Bondoc Peninsula, Tayabas Province, Philippine Islands

THE first representative of the Bureau of Science to visit the part of Bondoc peninsula in which the presence of petroleum has been known since the first years of American occupation in the Philippines was George I. Adams. During August 1909 Mr. Adams spent about one week on Bondoc peninsula visiting the various petroleum seeps known at that time, and in obtaining authentic samples of the crude oil for chemical examination. The principal results of Mr. Adams' work were given to the public in a press bulletin immediately after his return to Manila. He collected a sample of the petroleum from a shallow well drilled on the Bahay river by the Tayabas Mutual Oil Co. in 1906. This sample was analyzed by George F. Richmond and his report was published in *The Philippine Journal of Science*.[1]

In June 1910 Wallace E. Pratt visited Bondoc peninsula while engaged with Mr. Adams in a general reconnaissance of southeastern Luzon. *The Philippine Journal of Science*[2] contains data obtained by this visit, together with an opinion by Mr. Adams on the petroleum possibilities of the Tayabas field. In January 1911 Frank T. Eddingfield and Mr. Pratt spent two weeks in the oilfield. A report by Mr. Eddingfield was published in the 'Mineral Resources of the Philippine Islands for 1910 (1911),' pages 64-68.

In 1912 Warren D. Smith, Chief of the Division of Mines of the Bureau of Science, went to the United States on leave, with special authority from the late Paul C. Freer, who was Director of the Bureau of Science at that time, to visit and study the oilfields of the state of California that the information might be applied to the examination of the local field. Accordingly, Mr. Smith spent nearly a month during the summer of 1912 investigating the California petroleum fields. During the absence of Mr. Smith in the United States, some interested persons in Manila arranged for the examination of the field by a noted European geologist. It was decided to profit by his observations and experience as well as to help him as much as possible, and Mr. Pratt and F. A. Dalburg were added to the party. The party devoted a period of two and a half months (May 27 to August 11) to a detailed geologic and topographic study of the oilfield.

In February and March, 1913, Mr. Smith spent three weeks on Bondoc peninsula in company with Mr. Pratt, confirming and amplifying the results of the work already done in this region.

The report, to be published in *The Philippine Journal of Science*,[3] is based upon the findings of the major period of field work in 1912, but draws freely upon all the other investigations and contains all the information at present

*Bulletin No. 19, Bureau of Science, Department of the Interior, Government of the Philippine Islands.

[1]Sec. A (1910), *5*, No. 1.

[2]Sec. A (1911), *6*, No. 6.

[3]Sec. A (1913), *8*, No. 5.

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available to the Bureau of Science. The following data from the report of Mr. Pratt and Mr. Smith will be interesting:

The existence of petroleum on Bondoc peninsula is established by the presence of seeps of petroleum associated with inflammable gas at various places throughout the oilfields. The quality of petroleum which might be recovered by commercial exploitation of the field is undetermined and can be determined only through the drilling of a series of test wells. All the petroleum encountered so far is similar in character and of a good quality. It is of low specific gravity and contains a large proportion of light oils which would make it of relatively high value as a commercial petroleum.

The seeps are in highly inclined strata which are probably in all cases part of the structure of anticlinal folds. From this association it is believed that the petroleum in this field has, in accordance with the general law of petroleum accumulation, tended to collect in the crests of anticlines.

The petroleum occurs, associated with certain horizons, in an extensive series of beds of sandstone and shale (Vigo shale), which is similar in character to the oil-bearing rocks of productive fields, notably those of Japan. The principal seeps are found in the upper part of this series in a zone designated as the Bacau stage, which is predominantly shale, but which contains subordinate beds of sandstone. In its seepage, the petroleum is associated with the shale rather than the sandstone and may be observed in some cases to come directly from the shale. Beneath the surface where closed lenses of sandstone probably exist, the principal accumulation of petroleum would be expected in the more open sandy zones. At the surface the light oil appears to have escaped readily from the coarse grained beds and to have been retained only in the fine grained shale.

The petroleum may have originated, in part at least, in the Bacau stage of the Vigo shale where it is now found. Globigerina and other organic remains are found in the strata with which the oil is associated, the decomposition of which may have given rise to petroleum. There is a possibility, however, that the oil is not indigenous to the strata in which it now occurs, but has migrated from its source to another horizon. Beds which are concealed so that they cannot be examined at the surface and which, consequently, may be the source of the oil which is now associated with the Bacau stage of the Vigo shale, occur as: (1) members of the Vigo shale above the Bacau stage, concealed by the overlap of the Canguinsa sandstone which overlies the Vigo shale unconformable; (2) the basal portion of the Vigo shale which has not been uncovered by erosion; and (3) any sedimentary formations which may underlie the Vigo shale.

Drilling exploration should be conducted along lines which have been indicated and wells should be so located as to explore the Bacau stage of the Vigo shale thoroughly under favorable conditions of structure. The possible sources of petroleum outside the Bacau stage likewise warrant exploration.

The structure of Bondoc peninsula includes a number of anticlinal folds and the conditions along some of these anticlines are considered favorable for the accumulation and retention of the petroleum, whether it occurs in all or in any one of the horizons at which it is suspected. Areas considered favorable for prospecting by test wells have been outlined.

The character of the petroleum and the geologic conditions governing its

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occurrence are such as to justify the exploration of the most favorable parts of the field by drilling in the hope of encountering natural reservoirs which can be exploited commercially.

The following localities are considered most favorably as sites for the location of series of wells to explore the petroleum-bearing rocks of Bondoc peninsula. They are arranged as nearly as possible in the order of their suitability from a geological standpoint, locality No. 1 being preferable to locality No. 2, etc. However, owing to conditions discussed in the full report to be published in the *The Philippine Journal of Science*,[4] it is possible that oil may be encountered at any one of the sites, even though it be absent elsewhere. There are many places other than those listed which would be considered favorable in case exploration at any of the sites herein recommended is successful.

Locality No. 1.—The Maglihi anticline in the southeastern part of the peninsula, near Mt. Morabi. The structure is favorable, in that an anticlinal fold is clearly indicated and the strata are intact above the highest oil horizon. The presence of oil in this fold is proved by the seep at Banco. The anticline is acute and the strata in the eastern limb are steeply inclined, affording conditions similar to those which prevail in certain productive fields in California. The number of test wells required will depend partly on the results of the actual drilling, but probably a series of at least three wells should be drilled along an east-west line, one in the crest of the anticline and one in either limb at a short distance from the crest. Water and wood are available in the vicinity, but the locality is relatively inaccessible. It is about 6 kilometres from the coast and is about 250 metres in elevation.

Locality No. 2.—The Maglihi anticline in the valley of the Bahay river. The conditions here are similar to those in locality No. 1, although the structure is not clearly defined and may not be quite so favorable. Oil is present in seeps and has been obtained in moderate quantity in two shallow wells at Bahay. The locality should be tested in the same manner as locality No. 1. Bahay is comparatively accessible, the proposed general site being 4 to 5 kilometres from the coast at an elevation of 40 to 50 metres. An old roadway leads in from the beach along the Bahay river, which could be utilized. Wood and water are available.

Locality No. 3.—The Central anticline in the vicinity of Balinsog or Bacau. The structure is favorable and the presence of oil is indicated by a seep at Bacau. The larger size of the Central anticline affords the possibility of greater accumulations of oil than would be expected along the Maglihi anticline. The wells should be located across the strike of the formations, one well on the crest of the anticline, and one on each limb, as at locality No. 1. This locality is very inaccessible, being at 9 kilometres distance from the coast, with intervening elevations of about 300 metres. Wood and water are available.

Locality No. 4.—Ayoni anticline, about 1500 metres inland from the mouth of the Ayoni river on the west coast. The structure here, a gentle, well defined anticline, is more favorable probably than at any other place in the oilfield. There are no oil seeps along the crest, but, as is explained in the above mentioned report, the absence of oil seeps is not necessarily an unfavorable circumstance, and may even be considered a favorable condition. Test wells should be located as is recommended for locality No. 1. Water

[4]Sec. A (1913), *8*, No. 5.

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is available and there is some wood. The site is at a low elevation (20 to 50 metres) and is readily accessible.

Locality No. 5.—The Malipa anticline near Cabongahan. To explore this fold with a series of three wells, it would probably be advisable to locate one well on the crest and two along Malipa creek on the southern limb at varying distances from the crest. The structure is fairly good and there is a seep of gas with some oil on Malipa creek. The site is fairly accessible through the valley of the Vigo river, and wood and water are available.

Owing to the general similarity of formations, drillers experienced in California or Burma, or both countries, should be employed on the work.

It is recognized that it may prove desirable from data obtained in the course of exploration by drilling to modify these recommendations.

Copies of a map giving the topography and the geology of the oilfield can be obtained at the Bureau of Science. A typewritten copy of the report intended for publication in *The Philippine Journal of Science* will be placed in the Library of the Bureau of Science, where it may be read by those who desire to do so. The Bureau of Science will also furnish copies at the fixed manuscript charge.

Creating a Municipality

By GEORGE NELSON *

HERMOSA BEACH, in Los Angeles county, California, was incorporated in January 1907, and street improvement was the first step taken for the creation of the new municipality. A city engineer was employed at whose instance a boundary survey was started and a map of the city compiled. Centre-line surveys were also started, but in October 1908 this engineer resigned his position to take up other work, and the Board of Trustees appointed the writer as city engineer, giving him almost plenary powers to go ahead and do whatever work was necessary to get the main streets in town and leading out of town improved at as small a cost as possible. After a thorough discussion of the merits of the different kinds of pavements and their applicability to the sandhills of which Hermosa Beach consists, the property-owners, in conjunction with the Board of Trustees and the engineer, decided that a 4-in. asphaltic concrete would be the most economical under the circumstances, and general specifications for this class of work were drawn up and adopted. The writer did not consider centre-line surveys advisable at this time, as it would be almost impossible to preserve the stakes set on the survey until it could be completed and monuments set out. Hermosa Beach was at that time not much more than a flat sandy beach and a row of sandhills with but few houses scattered here and there to break the monotony.

Hermosa avenue was the first street to be brought to contract. It runs northwesterly and southeasterly, the

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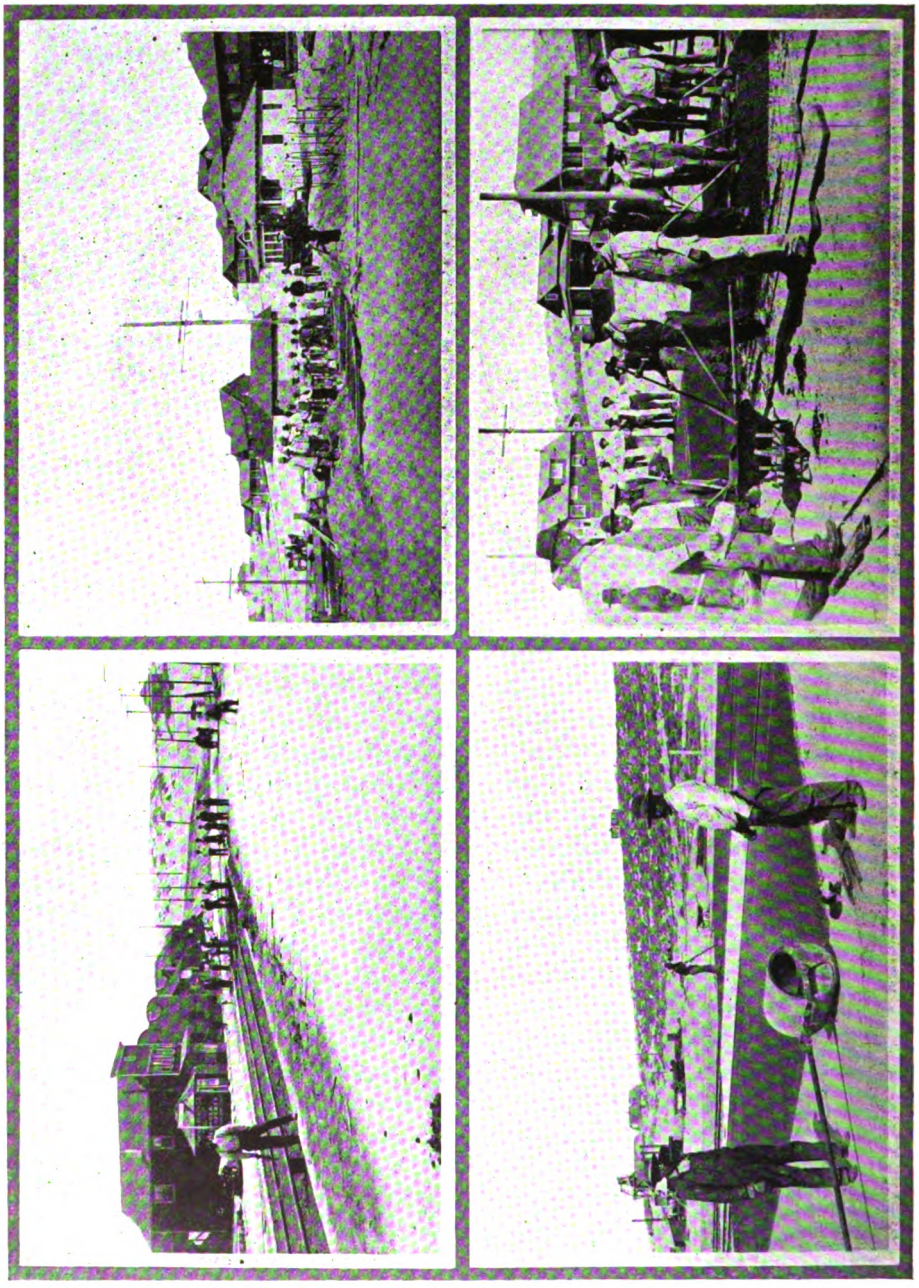

SECTION CREW LAYING TRACK ON SANTA FE AVENUE.
PAVING CREW ON HERMOSA AVENUE.

PREPARING TRACK FOR PAVING SANTA FE AVENUE.
RAILROAD CROSSING AT 8TH STREET. HAND ROLLER CREW.

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full length of the city, but the first contract included a section from the southerly city limits to the south line of 26th street. As Hermosa avenue at its northerly terminus did not connect with any street in Manhattan Beach, it was necessary to acquire a new right-of-way at 26th street diagonally across the block to the east of Hermosa avenue to get a 5% grade and connect with Manhattan avenue which is running parallel with Hermosa avenue and connects with Manhattan avenue in Manhattan Beach. The cross-streets already laid out all had too steep grades and the square blocks necessitated sharp turns around corners. It was deemed advisable to avoid this at any cost, as the road would be the main thoroughfare, and the two streets are now connected with a short tangent ending at the north in a curve with a 150-ft. radius and at the south in a curve with a 220-ft. radius, which, with the light grade, give all the facilities for travel desired.

Hermosa avenue is peculiar in that it is a 100-ft. street of which the centre 50 ft. is owned *in fee* by the Pacific Electric Railway Co., which here maintains a double track of the Los Angeles, Del Rey, Redondo line. This centre 50 ft. was deeded to the then Los Angeles Pacific Railroad Co. at the time (1901) of the subdivision of the land, as an inducement for the railroad to build its line to Redondo. These conditions complicated the work in that, for the purposes of the Vrooman Act, it left the east side 25 ft. wide and the west side 25 ft. wide as two distinct streets without any connection whatever. The city engineer placed the matter before the railroad company, which granted, without any objections, the desired number of crossings by proper street deeds. Before work could be started on any street, a datum plane to which to refer all grade elevations, had to be established, the crossings granted by the railroad company had to be named, and the grade had to be established on the street. These things naturally took time, especially when the writer soon found that he had to be official proofreader on all ordinances and resolutions that were to be published in the weekly town paper if he desired to see them go through without any errors. Besides this, the duties of the city clerk and the street superintendent were politely left for the engineer to do on all matters connected with improvements, and when Hermosa avenue was finally ready with plans, profiles, cross-sections, and specifications for resolutions of intention, it was found that an over-intelligent legislature had separated the construction of sidewalks from the Vrooman Act, and all that could be done was to construct the roadways. This policy was adhered to until in 1911, when the new improvement act was passed making it optional with the board which course to pursue.

As each side of Hermosa avenue was but 25 ft. wide, it took some discussion to come to an agreement as to how wide to make the roadway and how much space to leave for sidewalks and curb. It was finally decided to leave 4½ ft. for sidewalks and 20½ ft. for roadway. This arrangement does not look as well as it ought to, but is the best that could be done under the circumstances, especially as it must be remembered that what was needed was the roadway to enable owners of lots and houses to get to them with building materials and furniture. On this first job (Hermosa avenue) it was expected that sidewalks and curbs would be ordered in at once upon the completion of the roadway. It was not thought necessary to provide any header boards on each side of the road-

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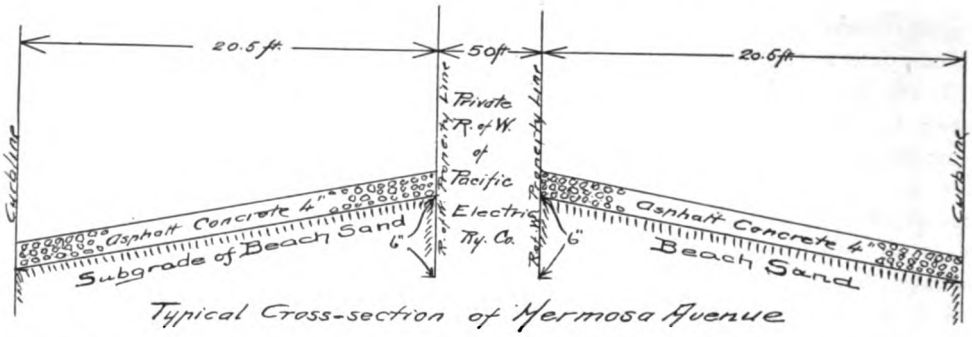
way, and only in isolated places where travel had broken down the edge of the pavement has it been found necessary to insert a protective board; the sidewalks and curves have only followed on a few short blocks. The improvement of Hermosa avenue consisted of a 4-in. thick asphalt concrete roadway and three reinforced-concrete culverts. The street was specified to be brought to subgrade with sand, this being the natural soil, and being confined between temporary header boards, it needed no rolling. In fact, rolling was out of the question, as the sand, even when continuously wetted during the night, would creep in front of the roller, and as boards were laid on top of finished subgrade to form a driveway for the asphalt wagons, it received a certain amount of compression which has proved sufficient on all the work done here. The surface mixture was:

	Per cent.
Broken stone passing 1-in. screen retained on ½-in. screen	32
Broken stone passing ½-in. screen retained on ¼-in. screen	14
Broken stone and sand passing ¼-in. screen and retained on 10-mesh screen	14
Broken stone and sand passing 10-mesh screen	29
Stone dust passing 200-mesh screen	5
Bitumen	6
	100

All materials were weighed before going into the mixer.

Bitumen was to conform to the highest standard in the paving practice which was specified in detail. Broken stone and sand was heated in the usual rotary driers and conveyed to the bin directly above the scale, which in turn is directly above the mixer, before going into the bin, which has four compartments. The material went through a rotary screen, separating it into four classes of stone specified; the stone dust was added directly into the mixer, and then the bitumen was poured in. The bitumen was heated in large kettles and pumped up to the mixer platform, where, after being weighed, it was poured into the mix.



Typical Cross-section of Hermosa Avenue

The temperature of the stone and sand was to be not less than 280°F., and that of the bitumen between 250 and 325°. The mixture was delivered on the street at a temperature of about 300°F., in bottom-dump wagons, spread, raked, and immediately rolled with a hand roller, which was followed by a steam roller weighing a little over 5 tons. Rolling the course continued until the pavement presented a smooth and even surface that did not show marks of the roller.

The slope of the pavement was from the right-of-way of the railroad toward the curb line, and was 6 inches in 20½ feet. The crossings granted by the railroad company were at street intersections and were the full width of the

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streets; they were also paved full width and raised slightly in the centre for the sake of drainage. The sand subgrade of all the streets in Hermosa Beach provides an excellent subdrainage that will materially lengthen the life of the asphaltic concrete roadways and thus reduce maintenance and renewal expenses. The contract for Hermosa avenue was let in August 1909 to the Barber Asphalt Paving Co., which was the lowest bidder at 13.9c. per square foot for asphalt concrete. The other bidder, the Fairchild-Gilmore-Wilton Co., bid 15.9c. per square foot. The work amounted to 349,092 sq. ft. of asphalt concrete, cost in all $53,-765.30, and was completed in May 1910.

When specifications for this work were adopted in the fall of 1908, the case of Warren Bros. against the City of Owosso had not been decided, and it was not thought that royalty would have to be paid, but before the resolution of intention could be passed, a decision was handed down sustaining the Warren patents which cover the specifications adopted. The city officials, however, decided that the asphalt concrete was best suited to the conditions, and license agreements for the work contemplated were obtained from Warren Bros. Co., and the work proceeded in due course.

The next piece of work to come up was all the alleys on the beach proper between Hermosa avenue and the ocean. It was here decided to use redwood curbs set along the property line, as the alleys were only 20 ft. wide. The curbs were 3 by 16-in. redwood planks, 10 to 20 ft. long, spiked to 3 by 4-in. redwood posts, 4 ft. long, set at the top ends 1 in. below the top edge of plank and 10 ft. between centres. Spikes were to be 6 in. long, three to each post. The holes for the redwood posts were dug with a posthole digger, as the sand about a foot below the surface was moist and compact. Most of these alleys had to be filled in for about half their length in the centre. This was done, like all other grading on the beach, with Fresno scrapers and the material taken at the ocean front below the high-water line. As a further proof of the density and compactness of this sand subgrade, it can be noted that after the fills had been made for some time, and before paving commenced, the gas company, which had occasion to dig up some of its old pipes in order to bring them further up in the grade, found the digging extremely hard, far more so than on any of the ungraded streets.

Asphalt concrete 4 in. thick, laid to the same specifications as Hermosa avenue, was used for the roadway, and the subgrade given a crown of 4 in., as it was found that the loose dry sand on top would compress slightly after the steam roller came into use, and it was desired to have at least 3 in. of crown on the finished pavement, to be sure of getting all the water off quickly, as it was very difficult to roll the pavement to a true templet surface.

The alleys were commenced in June 1910 and completed in September 1910. They amounted to 245,930 sq. ft. and cost $45,709.82. The unit prices for this work were 15.9c. per square foot for asphalt concrete and 19.5c. per lineal foot for redwood curb. Several smaller streets were improved under the same specifications at prices varying from 13.5c. to 18c. per square foot for asphalt concrete 4 in. thick. The difference in price is caused by the difference in grading, which, owing to the wind-swept nature of the sandhills, varied greatly even within the very narrow limits of some of the blocks. A block 250 ft. long would be at grade in one end and in the other have a

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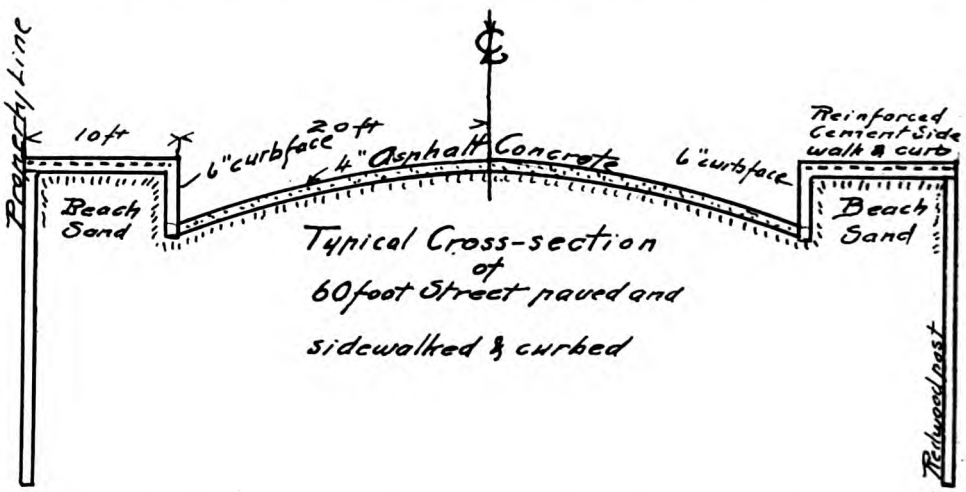
cut of 10 ft., making it difficult in some instances to dispose of the surplus material in the cuts. The grading of the sand made the scraper stock unusually leg-weary and sore, and often necessitated a rest of several days.

The next street to be improved was Manhattan avenue, which is parallel to Hermosa avenue and runs the full length of the town. It is 60 ft. wide between property lines, and it was decided to pave 30 ft. in the centre and a two-layer pavement consisting of an asphalt concrete base 3½ in. thick and 'Warrenite' wearing surface, and use a 10-ton roller instead of the 5-ton which had been used before. The new trustees that had been elected in April 1910 made the ruling that before any street work could be started, a petition should be presented bearing signatures of property-owners representing a majority of the frontage to be assessed. These petitions were all drawn up in the engineer's office and designated what work was wanted and what specifications were desired to be used after due consultation between some of the petitioning property-owners and the engineer. The street improvements of Hermosa Beach can thus be said to represent the wishes of the majority of property-owners at the time. Manhattan avenue was not always Manhattan avenue; the southerly 8000 ft. was originally La Clede avenue and the northerly 2000 ft. was Manhattan avenue and the property here belonged to persons who were against any improvements whatsoever, and the improvement of the southerly portion would not give the city the desired northerly outlet through Manhattan Beach to Center street, which was being improved by the County Highway Commission as a portion of the good roads system. The engineer therefore suggested that the Board of Trustees by ordinance change the name of La Clede avenue to Manhattan avenue and then present the petition with all the signatures available on the southern portion, which constituted considerably over a majority and therefore gave the Board of Trustees the right under the improvement act to go ahead and order the work. When the owners of the northerly 2000 ft. awoke to the fact that they had been outmaneuvered there was a row. It was then too late to avail them anything, and the work went head, the protesting people being of



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course the largest beneficiaries, as the improvement increased the value of their holdings.

The specifications for Manhattan avenue called for a bituminous concrete base 3½ in. thick, a 'Warrenite' surface 1½ in. thick, and an Oregon pine curb on each side to protect the edges, as no concrete curb and sidewalk was to be put in. The mixture for the base consisted of 50% broken stone not to exceed 2½ in. largest diameter, and 50% sand, with 7 lb. of asphaltic cement to each cubic foot of mixture. This was to be spread on subgrade and rolled with the 5-ton roller until showing no marks of the roller. This has proved an excellent mixture for the base. It is economical, sand being present on the ground in abundance and well suited for the work, and the use of rock instead of gravel cuts the freight charge down. It is compact and unyielding in that the sand just fills the voids in the rock, and 'Warrenite' when laid on this aggregate can be rolled immediately while it is hot. This is one of the chief advantages of the 'Warrenite' pavement, in that, being rolled hot, it gets the utmost compression at the right time, and the result is a most compact pavement. The 'Warrenite' surface consisted of a mineral aggregate of broken stone and sand and a binder of 'Warrenite' waterproof bituminous cement. To quote from specifications:

"The mineral aggregate shall be so proportioned that the mixture shall be of the following sizes: 40 to 50% large enough to pass a screen having circular openings 1 in. diameter and remain on a screen having circular openings ½ in. diameter; 10 to 15% fine enough to pass ½-in. screen as above and remain on a screen having circular openings ¼ in. diameter; 10 to 5% fine enough to pass ¼-in. screen as above and remain on a screen having 100 openings per square inch; 20 to 30% fine enough to pass a screen having 6400 openings per square inch, at least one-fourth of which shall be fine enough to pass a screen having 40,000 openings per square inch."

Each batch of mineral aggregate composed of the different sizes above shall, while hot, be incorporated in a mechanical mixer with 'Warrenite' waterproof bituminous cement heated from 200 to 250°F. until the combination is a uniform bituminous concrete. The amount of 'Warrenite' cement used in each batch shall be from 8 to 9½% by weight of the weight of the mineral aggregate and shall be accurately weighed and used in such proportion as thoroughly to coat each particle of stone and fill all voids in the mixture.

The surface mixture, prepared as above, shall be delivered on the work at a temperature not cooler than 200°F. or hotter than 325°F. When deposited on the street it shall at once be uniformly spread over the foundation to such a depth that after receiving its ultimate compression the finished surface shall have a thickness of not less than 1½ in. It shall then be immediately rolled with a steam roller having a compression of not less than 250 lb. to the lineal inch width of tire.

The completed 'Warrenite' surface shall be a solid, dense, bituminous concrete, the mineral aggregate of which shall have a high degree of inherent stability, and the completed 'Warrenite' surface shall have at least 90% of the specific gravity of solid rock.

Upon this rolled surface shall be spread, by a suitable spreading machine, enough 'Warrenite' flush coat composition to fill all superficial voids. Upon this flush coating fine gravel, sand, or stone screenings shall be spread in sufficient quantity to cover the flush coating.

The specifications for the Oregon pine curbs called for sound heart Oregon pine planks 2 in. thick and 12 in. wide,

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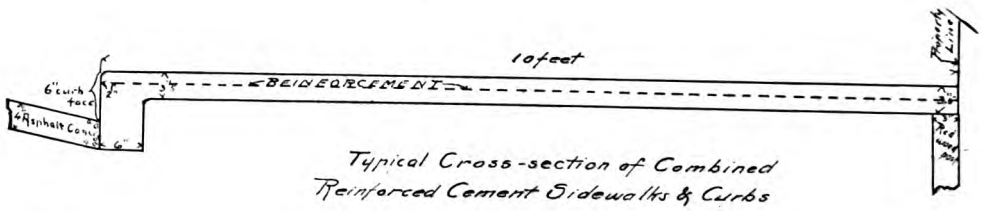
10 to 20 ft. long, to be spiked to 2 by 2-in. sound Oregon pine posts, 2½ ft. long, set with the top ends 1 in. below the edge of the planks, 5 ft. apart centre to centre. This curbing, which is cheap and efficient for the time being, is not intended to last forever, but is only expected to act in protecting the edge of the pavement and especially on fills to hold the subgrade from going out from under the pavement. In time, as the place builds up, cement sidewalks and curbs will have to be put in, and the wooden curb, having then done its duty, will be easy of removal. Manhattan avenue included 306,373 sq. ft. of 'Warrenite' and cost $65,077.67. The unit prices for this work were 19.5c. for the 'Warrenite' paving and 15.5c. per lineal foot for curb.



Typical Cross-section of Combined Reinforced Cement Sidewalks & Curbs

Included in the improvement of Hermosa avenue was the most westerly block of Santa Fe avenue. This is the central street in town running east and west and connecting on the easterly end at city limits with the county good roads system, but as was the case with Hermosa avenue, only the asphalt concrete roadway was built, owing to the street laws, during the years of 1909 and 1910. As Santa Fe avenue is the main business street in town, it was decided to put in the sidewalks and curbs on the block between the ocean front and Hermosa avenue, and also on a part of Hermosa avenue one block to the north and one block to the south in order to make the improvements as complete as possible in the centre of town.

The sidewalks and curb designed for this work were combined reinforced cement. The sidewalks were 3½ in. thick, the curb was 6 in. wide at the top, 6 in. wide at the bottom, and 10 in. deep. The radius at curb return was 8 ft. at street and 3 ft. at alley intersections. Three by four-inch sound redwood posts, 4 ft. long, were placed under the inside edge of walk (the property line) where indicated by plans and profiles. This was only done in case of fills where there was danger that the wind in the spring months would undermine the edge of the walk before it could be fully built up. The tops of the posts were to be 3½ in. below the top of the sidewalks, which meant that the sidewalks rested on the posts. The posts were usually set 5 ft. apart centre to centre. The concrete was made of a mixture of one part of cement, three parts of sand, and five parts of broken stone, and the finishing coat was one part of cement and 1½ parts of sand. The reinforcement consists of triangular 4-in. steel mesh with single No. 12 gauge longitudinal steel wires and single No. 14 gauge steel cross-wires. This wire mesh adds less than 2c. per square foot to the cost of the sidewalks, and has proved very efficient in counteracting the strains to which it is possible to subject an ordinary cement sidewalk. The reinforcement was inserted as fast as work progressed and was laid 2 in. below the upper surface and extended the full width of the walk and into the curb to within 2 in. of the face. It

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was required that the reinforcement should be free from flaws and weigh not less than 19 lb. per 100 sq. ft., its cross-section per foot of width to be not less than 0.0409 sq. in., and to have a minimum ultimate strength of 3262 lb. per square foot. The sidewalks were marked off into blocks 2 ft. square, a requirement that was rigidly enforced and to which in conjunction with the reinforcement is ascribed the success of this work.

Proceedings for the improvement of Santa Fe avenue running easterly from Hermosa avenue were started early and contract let, but owing to the pressure of the other work mentioned, work on this street was not finished until that on Manhattan avenue was ready to start. Santa Fe avenue ascended from Hermosa avenue at a 7% grade to Manhattan avenue, and then rose to Summit avenue on top of the range of sand-hills at a 6% grade, more or less, and descended to the Santa Fe railroad tracks at about a 3% grade. The street is 100 ft. wide, 50 ft. in the centre of which is owned by the Pacific Electric Railroad Co. Through the coöperation of A. L. Burbank, general manager of the Hermosa Beach Land & Water Co., the city engineer succeeded in having the railroad company agree to his grades and also agree to pave its 50 ft. with the same pavement as the rest of the street at its own expense. A cut of 10 ft. was made at the top of the hill, reducing grades materially both ways and creating high sightly lots on both sides of this street with its 80-ft. paved roadway and 10-ft. wide sidewalks on both sides. The surplus material from the cut was used to build up a row of lots on the north side of the street. These were from 20 to 40 ft. below street grade, the filling raising them several feet above established grade, improving the general appearance of the street and enhancing property values. The one block of this street immediately east of the Santa Fe railroad was improved with oil and 2 in. of rock. The most easterly portion deserves special mention as its improvement or non-improvement was used to obtain an advantage for Hermosa Beach that could not have been obtained otherwise. At the time the start was made in the Hermosa Beach improvements, Redondo Beach, the town adjoining it on the south, had a few surface-oiled streets, then in deplorable need of repair, and a few sidewalks and curbs. The railroad between Los Angeles and Redondo Beach had been built by the original owners of the townsite of Redondo, and, together with the land holdings still on the hands of the land company, had been bought by H. E. Huntington. Hermosa avenue in Hermosa is continued through Redondo to the centre business section of that town, but no steps were taken to improve the street, although the city administration in Redondo knew that it was desired both by the business men in Redondo and all the property-owners on the street with exception of the Redondo Land Co. It was claimed that that portion of Redondo was the 'industrial' section and that they did not need any paved streets, only railroad tracks. Redondo is, however, only connected with the Los Angeles good roads system by a street through Hermosa Beach, and the easterly end of Santa Fe avenue is this street. Several attempts were made by the Redondo board to induce Hermosa to improve this street so that they would have a good outlet from their town, but the engineer, whose decision in street matters always was final, advised the Hermosa Beach trustees to refuse to do anything in the matter until Hermosa avenue in Redondo had been im-

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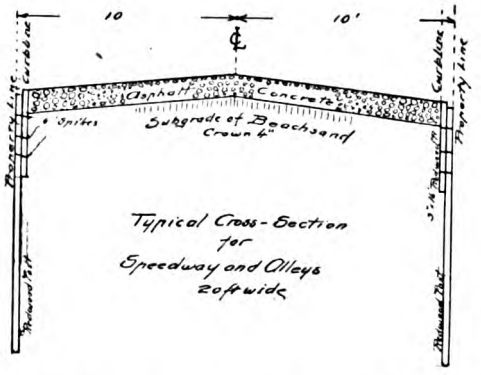
proved all the way. This advice was followed, and after discussing it for some time Redondo finally improved Hermosa avenue, thus giving Hermosa Beach the desired southern outlet. When the actual improvement of Hermosa avenue in Redondo had started, proceedings were begun in Hermosa to improve the easterly end of Santa Fe avenue. It was improved with 'Warrenite,' laid on an asphalt concrete base. The pavement was laid on the centre 20 ft., and the sides to the curb lines were surface oiled to keep the dust down. A wooden curb was put in along each side of the pavement to prevent the edges from



breaking off under the heavy lumber traffic that went over this road from the Redondo lumber yards. The crown was kept rather flat in order to leave opportunity open for the widening of the pavement at some future date when traffic conditions demanded it. El Camino Real, which connects Santa Fe avenue with Redondo, was improved a couple of years before by grading and 2 in. of crushed rock and oil. This kind of work was demanded by the property-owners, and owing to its short life it is now raveling and pitting. This work was done under the cash act and district plan.

The last great improvement in the sand-hill section of the town was Summit avenue and the cross streets. It took in Summit avenue at full length and all the streets crossing it that had not been improved before, with the exception of Second street. The improvement consisted of a 25-ft. asphalt concrete roadway and an Oregon pine curb on each side to protect the edges.

All this work was done under the previously mentioned specifications for this kind of work and did not develop any new feature except an enormous amount of grading. Summit avenue is on the very top of the sandhills, and the cross streets run down the hillside to Hermosa avenue. These sandhills have never been graded to any shape at all, and the spring winds have whipped them up in great hummocks at some places, while in others they have made 20-ft. holes. In order to get streets across all this, 'hogbacks' had to be cut through, the holes filled, and the grades established with two aims kept in view all the time: first, to get grades fairly passable by automobiles and ordinary delivery traffic, and second, and probably the most important, to get grades which would harmonize as much as possible with the surrounding conditions of the landscape. Even at that the land company, which owned considerable property along these streets, had to spend several thousand dollars in grading their lots after the streets were finished so as to get them into condition to present the most favorable appearance to the prospective buyer. As this latter work was planned and supervised by the city engineer, the results obtained were gratifying and remunerative to the company. With the completion of Summit avenue, the main improvements had been finished and access had been provided to all lots on the beach. Attention was now directed to smaller streets, pieces

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of streets, or sidewalks. The sidewalks on Santa Fe avenue from Hermosa avenue eastward to the Santa Fe railroad were put in, all reinforced, curb and walks joined. Eleventh street and Thirteenth street, between Hermosa avenue and the ocean front, were petitioned and paved with a 4-in. asphalt concrete roadway, reinforced sidewalks and curbs. Several changes in the specifications were made here in accordance with observations made during the construction and use of the already paved streets. The asphalt concrete roadway specifications were changed to include a flush coat and rock screenings acting as a finishing touch, the same as is used on the 'Warrenite' surfaces. The sidewalk and curb specifications were changed to include the Wainwright protective corner bar on all alley and street corners, and some further changes were made in the section on mixing and placing.

Hermosa Beach, in spite of numerous cross streets, has very few streets that run from the ocean across the Santa Fe railroad. Santa Fe avenue, now named Pier avenue, is the only street running from one side of town to the other, and the only other street of any importance that connects the beach with the soil section of the town is Second street. On the beach side of the railroad this street is a straight street 60 ft. wide, with an easy grade over the sandhill, but on the east side of the railroad the subdivider had done his work so carelessly that discrepancies and mistakes of 20 ft. were of common occurrence. Streets ran blind and had all sorts of kinks and angles in them. A portion of land had been sold to the Santa Fe railroad and no crossing provided for the street, and a small triangular strip which had been left between the spur and the main track was left on the hands of the owners and was also needed for the street. All this had to be straightened out and the proper street deeds secured, both from the railroad company and the property-owners. It took something like eight months to get the crossing deeds from the Santa Fe railroad. When the owners of the triangular piece of property were requested to make out a street deed to bring this street through, the usual tactics were resorted to and the city had to pay for the piece of land rather than have the improvement 'hang fire' any longer. Second street was improved with a 'Warrenite' roadway cement sidewalk and curb, and the portion on the beach side was reinforced work. The result of the work done is shown by a nearly tenfold increase in property values.

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The New Big Bear Valley Dam

By JOHN S. EASTWOOD *

BIG BEAR VALLEY is of glacial origin and lies on the summit of the San Bernardino mountains about 30 miles in a direct line easterly from Redlands, California, at a general elevation of 6750 ft. above sea-level. It extends across the summit of the range which is the dividing line between the rich alluvial coastal San Bernardino valley and the great American desert. It was early considered as a possible storage site and was finally developed by F. E. Brown as a source of water-supply for the city of Redlands and vicinity, and was the means of creating that now famous citrus area, one of the most highly cultivated sections in the United States. Mr. Brown's development consisted in the erection of the famous example of single-arched dam, noted as the lightest section masonry single-arched dam in the world.

The old dam has been described many times, and many critics of note have visited it. It has been condemned by many as absolutely unsafe. The adverse criticism was so profuse and emanating from men considered as such high authorities that the reservoir was not until the last few years allowed to fill to its complete capacity, the owners having feared that there would be great danger to the people of the valley below should the dam be overtopped. But, as often happens, the winters of 1909-10 and 1910-11 produced during winter floods a run-off from the drainage area so large that the dam was overtopped during both winters to a depth of over 2 ft., and the earth that had been piled against the lower side was carried away.

The practical proof of the strength of the old dam was in this overtopping, but in the light of more modern investigation of stresses in dams of arched shapes, it is also found that the old dam has a very high safety factor, and is, in reality, one of the extra strong dams now standing to prove that the arch is the true form for the best resistance of liquid pressures.

The amusing feature of the attempts to strengthen the old dam was the piling of loose earth and rock against the downstream side and which the water, topping the dam, immediately carried away. Of course, it is apparent to anyone who has given the subject of the stresses in a water-loaded arch any thought whatever, that this material took no load and added no strength whatever to the dam.

The old dam was built in 1884 by Frank E. Brown, C.E., and, owing to the difficulties of transportation and the pioneer conditions, was a very difficult job, its light section being selected to reduce its cost to the minimum. A peculiar feature of its construction was that it was built up from a float on the water side, the water being allowed to rise with the dam. This method has been given the credit by some engineers for the 'paradoxical' strength of the dam. Frankly, it was a good test to submit the green structure to the full water pressures. The argument for its adding strength was that it compacted the joints of the masonry, bringing the

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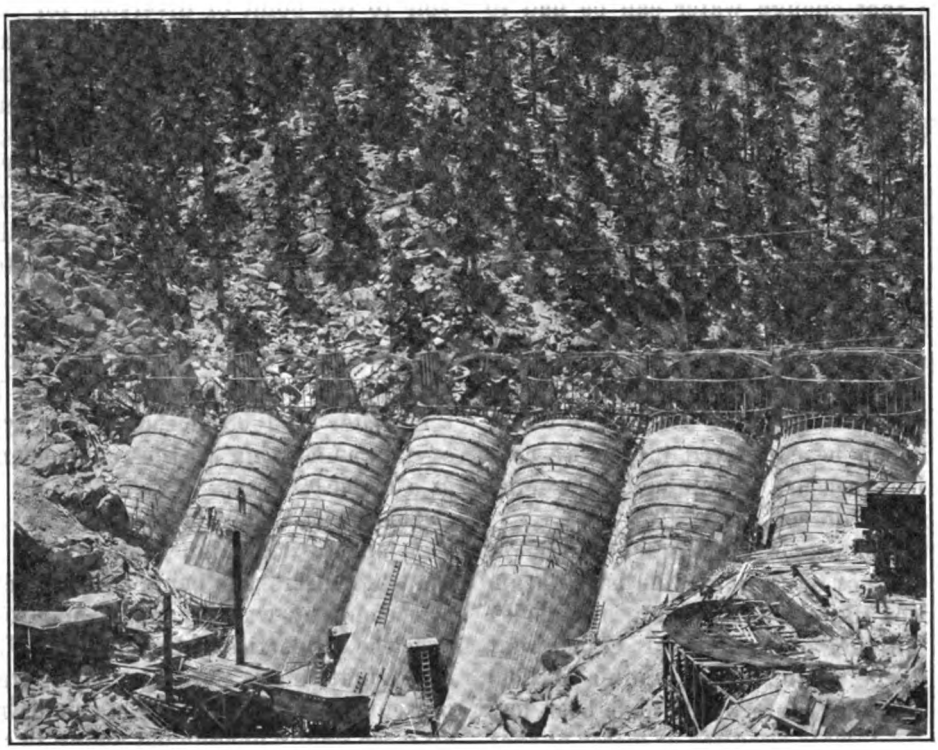
blocks of stone into a more intimate contact during the time of setting, the mortar being a lime-tempered cement in which coarse sand was used.

The old dam was and is a better structure than it has ever been given credit for, and while it was built for economy only, it met more nearly the requirements that later investigations have shown to be fundamental than many of the more widely heralded structures that were built regardless of cost. Frank E. Brown, the pioneer, builded better than he knew, and his work has stood the tests of flood to confound his critics whose strictures on his work now sound like those made as to the futility of Fulton's first steamboat.

While the old dam was not designed on the exactly correct lines for a single-arched structure, and is said to have two radii, owing to the interference of a tree with the full sweep of the wire used to strike the circle, that is not such a great fault when men high in the profession, even in these latter days, design dams with two radii, one twice the other. It is, on the whole, so well designed and built that had it not been



FRONT AND REAR ARCH FORMS AND REINFORCEMENT.

for the impossibility of emptying the reservoir, it was the first thought of the writer to increase the reservoir capacity by proceeding to repair the old dam by giving it an impervious water face and then raising the crest to that required for the additional storage capacity. This could all have been done quite cheaply, compared with the cost of a new dam. It constituted the supply necessary for irrigation, and, owing to the variable precipitation of this re-

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gion, was of great value and necessity. This left, as the only solution of the problem, the erection of an entirely new dam to take its place.

The variability of the precipitation and the high value of water in this vicinity for the intensive culture of citrus crops, made it advisable to prepare for cyclic storage, as it is only by carrying over from years of unusual precipitation that enough water can be had to meet the requirements for irrigation. The lands irrigated are not of a quality nor so situated that they will sub-irrigate, so the increased demand for moisture by the growing trees must be met by an increased water-supply.

The unit of millions of gallons is an awkward one for the conception of water quantities for irrigation, but it is in the terms in which the figures were previously made up, and the conception of volume by the nomenclature is merely a habit of thought anyway, so it can be converted into more convenient measure of volume by those desiring to do so.

It was proposed to erect a dam to a height of 65 ft. above the base datum zero of the old dam, giving a capacity in millions of gallons of 17,000, but the large run-off of the winter of 1909 showed that there would have been lost a considerable quantity of water at that height, so it was finally determined to run it up to the 70-ft. contour, giving it a capacity of 21,000 million gallons. This capacity in the completed plans, in order to give it in even feet of the sea-level datum, was raised finally to the 72-ft. contour, giving a capacity of 22,880 million gallons, the new datum giving a crest elevation of 6746 ft. above sea-level.

These figures are given on the curve chart showing the relative storage capacity of the Big Bear Valley reservoir, and was made up from the detailed contour surveys of the site in the company's office. The curve also shows an ultimate possible storage at this site of 27,810 million gallons by raising the dam to a final height at the crest of 6751 ft. above sea-level.

Reports were made on the project of the increased storage by the engineers of the two companies that use the water for power on its way from the reservoir to the point of diversion for irrigation. A report and proposed plans were also furnished by the late James D. Schuyler, of Los Angeles, who proposed a standard gravity section concrete masonry dam for the site. The estimated cost of the solid dam was over twice that of the Eastwood multiple arched dam, proposed by the writer, and the management of the company, being satisfied by the recommendation of the owners of the Hume Lake dam, which is of the same type and built by the writer in 1908, accepted this type of dam as meeting all the requirements at a much less cost.

The Bear Valley Mutual Water Co. is a mutual irrigation company, all of the water users also being stockholders. The company was organized and took over the properties of the old Bear Valley Irrigation Co. Several schemes were presented for utilizing the old dam, but all were finally abandoned owing to the necessity of emptying the reservoir, and so the plans for the multiple-arched dam were accepted.

During the interim between the building of the old dam and the new, a foundation for a loose-rock dam was laid and carried up a few feet by William Ham Hall, then the engineer for the company. This was done in 1894, about ten years after the completion of the old arched dam.

This foundation occupied the only available site immediately below the old dam and had to be cut through in ex-

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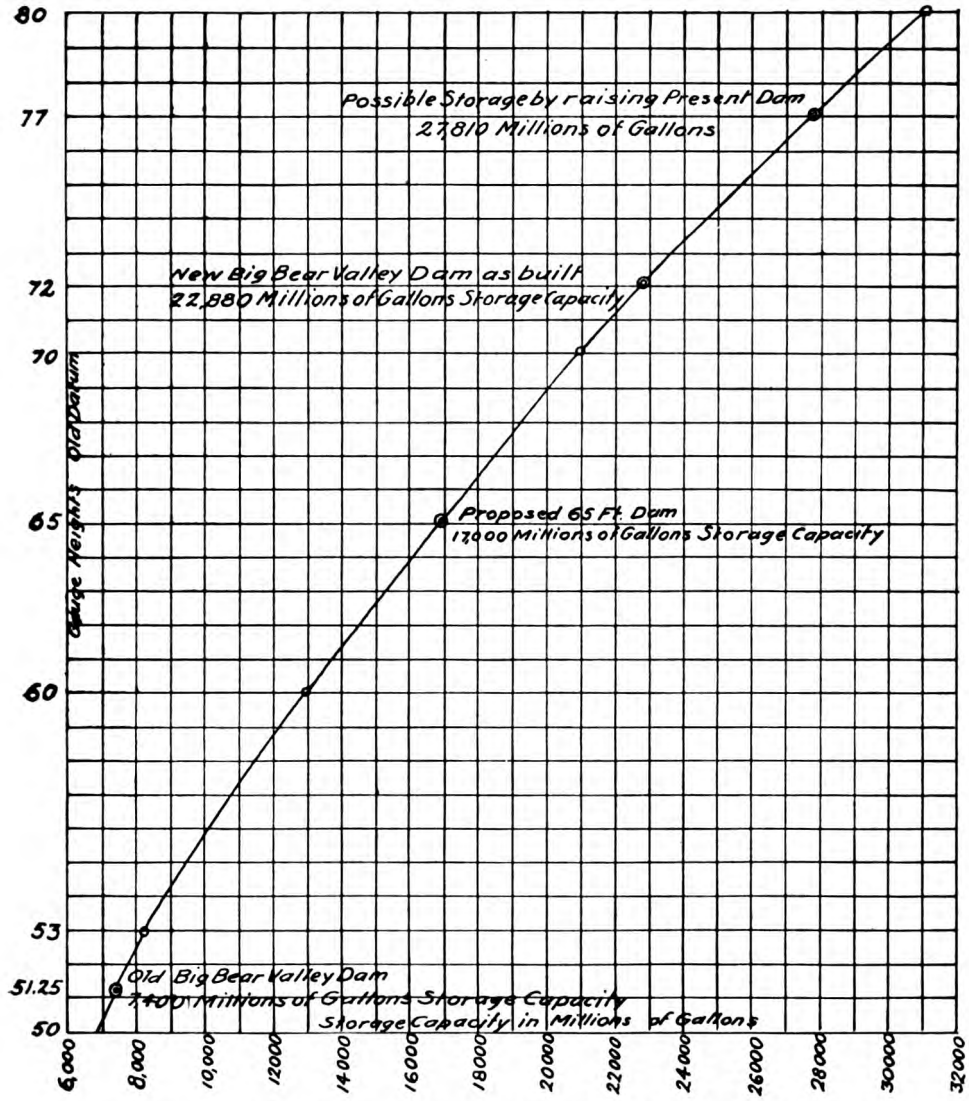

CURVE SHOWING RELATIVE STORAGE CAPACITY, BIG BEAR VALLEY RESERVOIR.

cavating for the new multiple-arched dam, this site being about 150 ft. downstream from the old dam. Meanwhile the winter freshets during 1909-1910, having leveled the earth fill behind the old dam, filled the space between the old dam and the Hall-base level, so that the excavation was very much increased at this site.

At the beginning of the work it was the plan of the company to build a dam only to the height of 65 ft. above the datum zero of the old dam, but before the work was actually begun, as stated above, it was altered to 72 ft., the equivalent of elevation 6746 ft. above sea-level. The 65-ft. dam was planned, and an estimate made of $80,000 for the placing of 2900 cu. yd. of concrete over all cost, or $27.59 per cubic yard. The final plan for the dam as now built was to crest-line contour elevation 6746, con-

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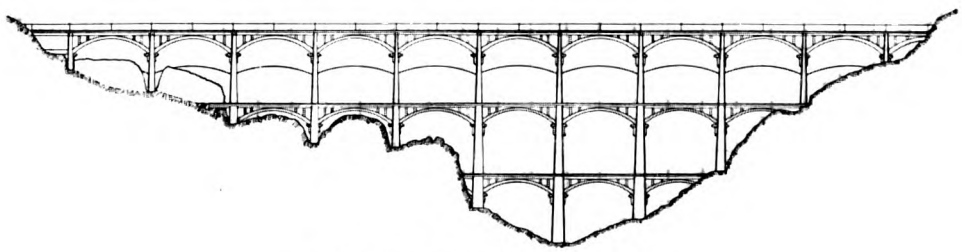
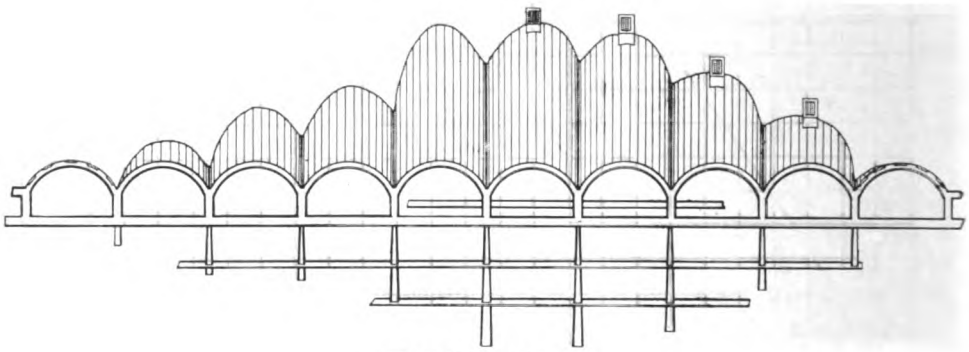
sisting of ten spans of 32 ft. each, and short wing walls at the ends to bring the total length up to 363 ft. on the crest, the greatest height above bed-rock being 92 ft. The ten spans of 32 ft. each from centre to centre of the buttresses call for ten arches and eleven buttresses to support the arches.

The water face of the structure and the rear edge of the buttresses are given such slopes as to bring the resultant of the water-pressure load and the weight load of the structure through the centre of the base of the buttresses at the highest portions.



DOWNSTREAM ELEVATION OF DAM.



PLAN VIEW OF DAM.

The slope depending on the other dimensions of the structure, in the case of the Big Bear Valley dam is 0.75 to 1, or 36°52′ from the vertical for the water face up to within 14 ft. of the top, and vertical from that point to the crest.

The slope of the downstream edges of the buttresses is 0.5 to 1 from the bottom to the top, the vertical top of the arches giving them a top width of 10 ft. from the spring line to the back edge. The buttresses are 1.5 ft. thick at the top and increase in thickness with a batter of 0.016+ ft. per foot of height or 1 in 60 on each side to the base for all heights. The arch rings are 1 ft. thick at the top and down to the bend, from which they are increased in thickness at the rate of 0.014 per foot measured on the slope to the base, or 1 in 72.5.

The arc of the extrados of the arch ring is 140°8′ from top to bottom, the radius being maintained at 17 ft. and the rise at 11.22 ft., the extrados being therefore a cylindrical surface uniform throughout, all changes in dimensions being made on the intrados of the arch. Thus at the top the radius of the intrados is 16 ft., the arc 145°8′, the rise 11.74 ft. At 80 ft. from the top the thickness of the arch ring will be 2.15 ft., the radius of the intrados 14.85 ft., the radius of extrados less the thick-

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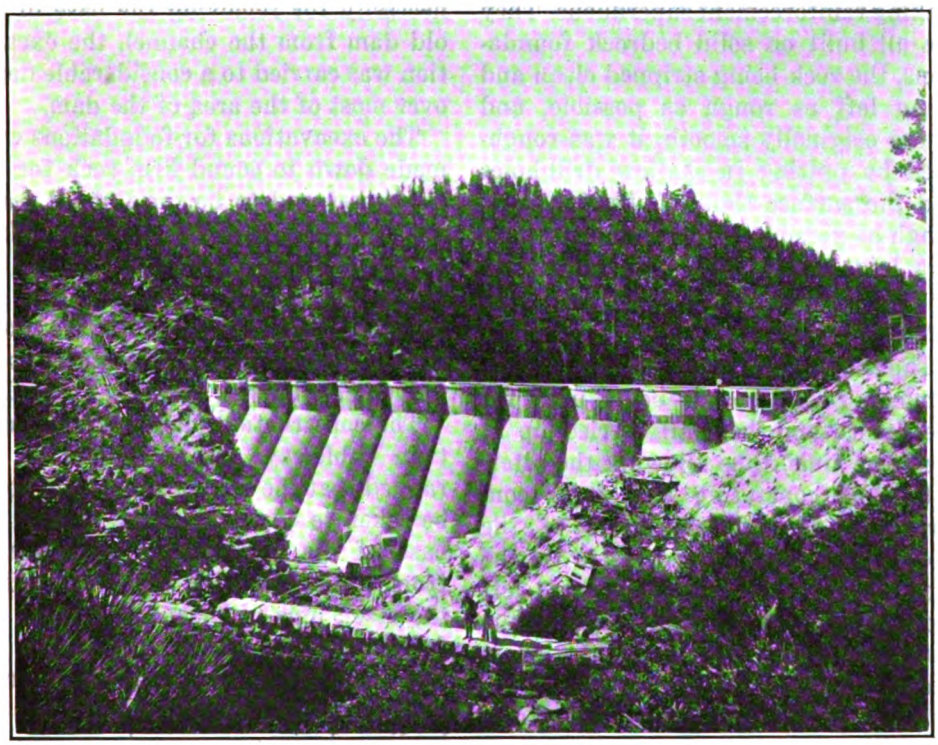
ness of the wall, the arc 140°48′, the rise 10.49 ft. In all cases the clear span, radius and rise of the intrados decrease from the top downward.

Strut-tie members are provided between the buttresses to stiffen and take the lateral thrusts that might be set up by seismic disturbances or vibrations of any kind. These strut-ties consist of a combination of 'T' beam and a supporting arch all tied together by heavy steel reinforcements.



DAM PRACTICALLY FINISHED, READY FOR PLASTERING.

The 'T' beams are 1 ft. thick and 2.5 ft. wide with a 1-ft. stem, set on an arch 1 ft. square at the crown and thickening to 1 + 2 ft. toward the spring lines having two spandrel posts on each side connecting the beam and arch, all united into one piece.

Following out the same general scheme of arrangement there are provided copings for the arches and the tops of the buttresses with 9-in. projections, making the arch cope 2.5 ft. wide and that on top of the buttresses 3 ft. wide. The beam of the top strut members is built 4 ft. wide to serve as an extra stiffener, and as a comfortable footwalk across the dam. The footwalk is provided with cable railing on both sides to make it a safe place upon which to walk. To add to the architectural effect of the structure, the arches of the strut members terminate in imposts, built as part of the buttresses.

The struts are reinforced with twisted steel rods, all being tied together and continuous through the buttress walls. The ends entering the buttresses are attached to other reinforcements passing crosswise into the buttress walls, forming roots by which the stresses in

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the beams may be transmitted and distributed in the buttress walls.

The ends of the strut members are all tied into the granite rock at both ends of the structure by hooking the reinforcing rods in drill-holes in the rock. The buttresses are not reinforced except that they are tied to the arch rings and the strut members, their shape and the loads they are to carry making reinforcement superfluous. They are all built on solid bedrock foundations, the rock being stripped clean and being left as rough as possible, and where originally smooth, it was roughened by putting in shallow drill-holes and the surface shot off, leaving it as rough as possible. Before any concrete was laid, the surface was thoroughly cleaned by means of a water jet under strong pressure.

The buttresses were all built first, common rough boards being used for the forms, and were all carried up at the same time, thus allowing the alternation of concreting and form construction, on different parts of the work. The reinforcing rods to tie the arch rings to the buttresses were left protruding from the front edges of the buttresses which were finished a short distance back of the spring lines of the intrados of the arch ring. All of the buttresses were built during the season of 1910 and stood till the spring of 1911. The water face was carried up as a whole, starting from the lowest place and keeping the work about level across the top. The forms for the under side were carried up to a considerable distance ahead of the outside forms and served as a working base for setting the reinforcement and for spacing the outside forms to give the required thickness of wall.

The country rock at the site is an intensely fissured syenitic granite, the northern exposures being quite sound though highly fractured, while the southern exposures are decomposed to a considerable depth below the surface. The solid parts of the rocks lying in hard dikes, show the effects of the glacial action, while the decomposed portions consist of an overlying soil, and gradually harden with depth. On account of the fractured condition of the rock at the ends and owing to the necessity for removing the base of the old dam from the channel, the excavation was carried to a considerable depth over most of the area of the dam.

The excavations for foundations were made down to sound firm rock for the buttresses and to bottoms of all seams for the water face foundations. Much of the excavated material that lay between the trenches was cast out, the balance being conveyed to the down stream side by means of derricks and a universal cableway carrying a flat skip.

The construction plant consisted of a twin cableway, steam driven, so arranged that the skip or other load could be taken to any part of the area of the base of the structure; a rock quarry from which the rock was conveyed to the stock bins by means of a cable lift for the empties and gravity return under drum brake for the loads; a rock-crushing plant; sand bins and sand unloading device; a concrete mixer; air compressor and receiver; steam pump for water supply; flat cars for concrete buckets; carpenter and blacksmith shops.

A quarry was opened on the hillside, in a hard dike above the south end of the dam to supply the rock for the concrete aggregate. Air was conveyed from the air plant, which consisted of a steam driven Westinghouse cross compound compressor and a small air-receiver, to the quarry, where it was used to run the Ingersoll Rand hammer drills. Air was also piped to various

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parts of the foundations where most of the drilling was done with it, using the hammer drills. The rock was broken in the quarry to the sizes required for the crusher and was conveyed by gravity to the rock-crusher in side-dump Koppel cars of 36 cu. ft. capacity.

For crushing the rock for the aggregate a No. 3 Gates crusher was used, from which the crusher run was discharged into a stock bin, from which it was drawn into a measuring box, thence discharged into the charging hopper of the concrete mixer. The sand content of the concrete aggregate was gathered from the washes of the streams entering the lake, and was conveyed to the old dam by means of scows towed by motor boats. From the decks of scows it was loaded into a skip made from a mining car body, hoisted over the old dam and dumped into the sand stock bin near the mixer. Sand was scarce and it required a good deal of care to get it in the quantities and quality required for the work.

It possibly cost more than would a manufactured sand made from the granite rock at the site, though either way it would have been expensive, owing to the high freight and fuel costs. Riverside portland cement was used in the work, being tested at the mill by Edwin Duryea, chemist for the Los Angeles aqueduct. All of the material and supplies were hauled by wagons from Victorville, a distance of 55 miles and over a summit 7600 ft. above sea-level, with grades over 30% in places, the level parts of the road being in heavy desert sand. Part of the hauling cost was at $20 per ton and part at $25 per ton. During 1911 some freight came by way of Santa Ana cañon at $30 per ton.

Wood fuel was used for generating steam in the two hoisting engine boilers and in the two stationary boilers used for driving the rock and mixing plants and accessories. While surrounded by forests, wood was a very expensive fuel owing to its low efficiency and the cost of its preparation. The timber consists of Jeffery pine, which is very inferior for fuel and so knarly that powder used for splitting often blew a hole in a 4-ft. stick instead.

For the hoisting engines the wood was hauled on wagons and for the boilers in the bottom of the gorge it was taken on barges and towed to the old dam, thrown over and wheeled to the boilers. The hoisting device was a universal cable system and was so arranged that any and all parts of the work could be reached by it. It consisted of two main track cables each 2¼ in. diameter run across the gorge and anchored at both ends in the rock. At one end of each cable was provided a turn-buckle take-up, so that the cables could be tightened to any desired degree. Upon these track cables were placed carriages, provided with two track wheels, two wheels to prevent derailing from rebound, also two sheaves to take the hoisting lines. The universal movement was obtained by the use of two double-drum American hoisting engines and four lines by which all movements forward, back, and across were made.

Each engine took one of the hoist lines and one of the haul lines, this arrangement making easier work for the engine men, each of whom had a part of each operation to perform. The hoist lines passed from the drum to a head-block through a sheave lying flat, thence at right angles to a swinging sheave, thence under the track cable to the carrier, thence through the near sheave down to the single loose sheave carrying the load hook, thence back through the other sheave and off to an

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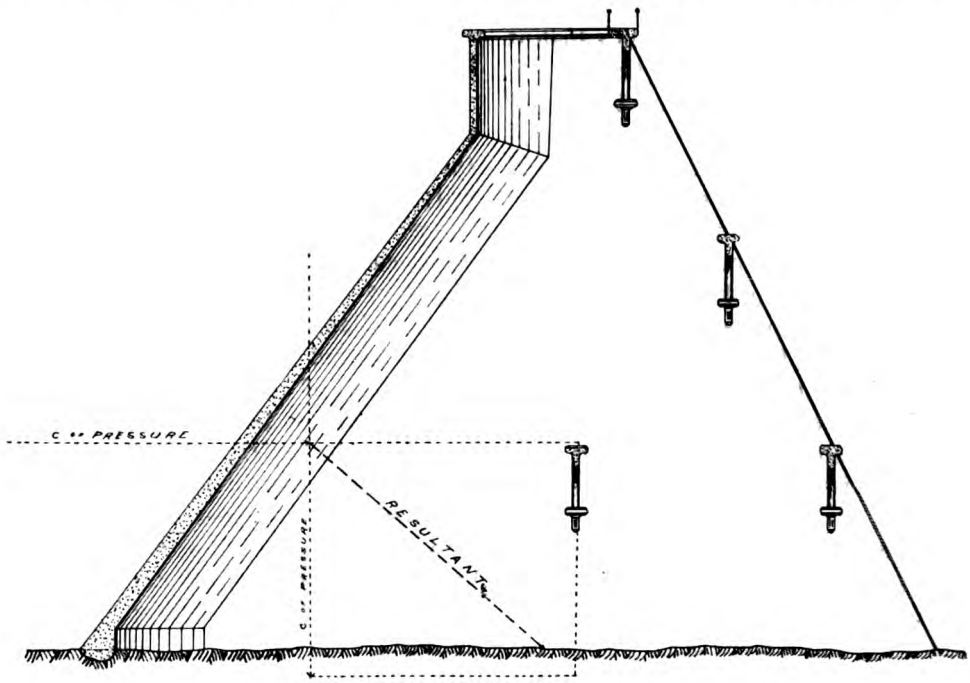
anchorage at the opposite side of the gorge under the track cable. The single loose sheaves were fastened together in a ring and swivel, to the edges of the housings of the sheaves by a short chain to prevent twisting. The inhaul and outhaul lines ran to a sheave on a platform on a tree to one side of the dam outside of the track line, across the gorge to another tree and sheave, then to a sheave at the middle of the end, then to the carriers, being fastened to each carrier by means of a bridle line into a clevis at the top of the end of the carrier. The direct inhaul and outhaul line of course ran direct to the near side of the carrier through a sheave at the head-block, and was attached to the carriers in a similar manner. The operation was very simple, consisting in hauling the lines in or running off under brake, all being done by direction of visual signals given by a flagman who directed all movements and who stood in such a place as to be able to see the signals of the foreman of the gang at the work. The hoist men took no signal except from the signal man, who took them only from the foreman in charge, so there was never any confusion, the skill of the crew becoming so great that any amount of movement could be accomplished at a place out of sight of the engines. The plan worked well, for the speed was determined by the motions of the flagman, who became the nerve centre of the hoist system and controlled all movements.



SECTIONAL ELEVATION OF DAM.

Machinery, boilers, cement, rock and earth, lumber for forms, and the precast concrete members were all handled with this apparatus. Forms were hoisted, concrete buckets handled to place, and finally the plastering was done from this skip.

The interest of the watching public often became greater in the hoisting plant than in the structure itself, novel

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though it was, and the old dam was used as a grand-stand for the stadium where the work was being done on the new dam.

The concrete plant was situated at the bottom of the gorge, there being no room for it elsewhere, and was so arranged that all of the aggregate was brought to it by gravity, the sand and rock being run from measuring boxes to the charging hopper of the mixer. The mixer was a 9-cu. ft. Ransome, and discharged into Insley controllable bottom-dump 22-cu. ft. buckets, set on small flat cars running on a short spur track, long enough to pass them out into the clear where the buckets were exchanged and the full one taken to place by the cableway.

The forms were built of rough pine lumber hauled from a sawmill in Holcomb valley, about 6 miles from the site. It was delivered at the site at a cost of $28 per 1000 feet.

The buttress forms were built in sections 8 ft. high, consisting of 2 by 4 studs placed 2 ft. apart vertically, a cap being placed horizontally at each 8-ft. rise. The frame work was first erected, after which 1-in. boards were nailed to the inside of this frame held in place by means of spacing ties across the top and by stay wires and wooden struts between. The wooden struts were placed so as to be removed as the concrete reached them, the twisted wire ties remaining in the concrete, 'X' bracing wires also being used to bring the forms to line and to give them lateral stiffness. A description of the forms will be of interest as tending to show how simple and light they may be built if they are properly braced.

The forms of the intrados of the arches were also of wood. Built-up liners, made of 1-in. stock cut to the required curvature were nailed together and formed the base for the studs, which were also 8 ft. long, the studs being nailed to the line of the outside of the liner and set radially, toe-nailed at the bottom and through nailed at the top. To these studs were nailed ½ by 6 in. boards bent to fit, doubled and lapped to make a tight form.

This makes a surprisingly simple and light form for an arch centring which is always thought of as very heavy with many supports, but there was no support other than the light liners, which were held by means of wire slings to the projecting reinforcement. At first thought it would seem that this form would sag and give way, but as the wall is carried up horizontally the arch itself carries the load.

The outer forms were made of Ferro-inclave set against angle steel ribs, the ribs forming a reinforcement and support for the form, which is left in to give a base for the plaster coat and act as form reinforcement and a water-tight film as well. The outer form is held away from the inner form by means of struts that are removed as the wall is carried up. The forms for the beams and copings were made of 1-in. stock held in place by means of brackets and ties across the top. The reinforcement consists of square twisted rods and of steel angles. Twisted rods were used for all reinforcement except the ribs for the water face which consist of 3/16 by 1½ in. angles, bent with the corner of the angle outward upon which the Ferro-inclave sheets were fastened by means of clips and stove bolts.

The concrete for the buttresses was proportioned as a 1 : 2½ : 5 mix as nearly as possible, and that for the water face was a 1 : 2 : 4 mix, tests being made in order to obtain the densest mixture that the materials could produce. In the buttress forms the concrete was laid in layers and well spaded away from

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the forms, and was placed so as to keep the rear ends higher than the front. At the end of a pouring, stones were placed in the concrete for joining to the next succeeding work. Before concrete was poured on old surfaces, they were roughened with a pick, loose particles all being shoveled out, and the whole surface then thoroughly scrubbed with a water jet under pressure, washing out all of the remaining loose materials. The surface was then sprinkled evenly with dry cement and the concrete immediately laid over it.

The concrete in the arch rings was more difficult to place but it also was laid in layers, the thicker walls tamped on the inside and tapped on the outside while the thin walls, that were too small to allow a man to stand in them, were tamped by means of tapping the Ferroinclave forms, causing the concrete to settle down tight. The tests and observations of the writer as to the efficacy of this method of making dense concrete were borne out by the resulting quality of the work placed by this method and it is the only way to get the very best results.

In the case of walls the tapping must be light and confined to the portions of the forms near the top of the concrete on the inside. Light wooden mallets were used for the purpose in this instance, but in later work where compressed air is available, short stroke air-hammers are specified for doing this work.

When the dam was entirely completed, there was placed on the Ferroinclave foundation a cement wash coat, two coats of cement plaster and a wash coat over all. The plastering was done from the flat skip held in place by the conveying cable system, the workmen taking aboard a supply of the raw materials and mixing the mortar, as used, on the platform.

The spillway, owing to the large area of the reservoir and small drainage area and run-off, was placed at the ends of the structure, there being provided 10 openings each 6½ by 4 ft., and provided with flash boards, so that the whole of the opening can be closed to store water to the top of the dam, following the winter freshets. The water from the spillways will flow into a bowl-shaped basin of concrete and be discharged below the dam, flowing down the slope on the bedrock.

The spillway has over twice the capacity of that in the old dam for a storage capacity of over three times, though it may never be used unless an unusually wet winter should occur after a preceding one with a full reservoir. However, no damage could be done were the water to flow over the entire crest of the dam, as it is all on solid bedrock foundations. The outlet works, owing to the small demand on the water supply, which is an auxiliary supply, consists of four 12-in. openings. The water ends of these are screened by means of short pieces of T-rail set vertically in concrete, two short pieces of pipe being set in each bell-mouthed opening and passing through the arch wall to the gate pier on the under side of the dam.

The outlet gates are set about 10 ft. above the bottom of the reservoir and at the lower end are placed a butterfly valve and a gate valve set tandem, an elbow of 90° being bolted to the flange of the valve gate, discharging the water downward through a section of steel pipe set in the gate pier. The water from this vertical pipe is discharged from the side of the pier through an elongated opening in the inside or toward the spring line of the arch of the dam, under the level of the water in the pool. This pool consists of the space between the two middle buttresses. This

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method of discharge stills the water and it is taken out to the creek bed below over a Cippoletti weir where the water can be accurately measured as discharged. A well in the pool is provided for a gauge measurement and also a well for a recording gauge float. A concrete foot-walk provided with an iron gate leads from the rear to the gates, making in all one of the most complete and convenient outlet works possible to devise.

Owing to the short seasons at this altitude, it required two summer seasons to complete the dam. It was impossible to get over the roads, one passing over a summit 7800 ft. and the other 8200 ft. above sea-level, earlier than about the first of June with loads, and the roads were closed after October.

A comparison of costs and results is of interest as showing the status of the multiple arched type of dam as compared to the old dam, the lightest section of masonry dam possible. The size of a dam is determined by the opening closed. The new dam is 363 ft. long on the crest, 63 ft. longer than the old dam, 92 ft. high, 31 ft. higher than the old dam, hence the following comparative figures will be of interest.

THE OLD DAM	
Contour of full reservoir (old datum), feet	51.25
Cost of structure	$125,000.00
Capacity of reservoir, millions of gallons	7,400
Cost per million gallon capacity	$16.76
NEW MULTIPLE ARCHED DAM	
Contour of full reservoir (old datum), feet	72
Cost of structure, less salvage	$133,528.42
Capacity of reservoir, millions of gallons	22,880
Cost per million gallon capacity	$5.83
Total number of cubic yards concrete	4,684.2
Overall cost per cubic yard	$28.51
Increase in capacity over old reservoir, per cent	309.2

The ratio of efficiency of the old dam to the new dam is as 1 to 3.092, assuming the cost per unit of area of opening closed as being proportional to the total relative costs of the structures. As the additional 31 ft. of height is in reality added to the base of the new dam, it will represent a much greater difference, the estimated cost of a single arched dam for the same site being about double the cost of the multiple arched dam. The bulk of the material in the old dam was the granite rock on the ground, while the material for the new dam consists to a greater extent of material that had to be hauled to the site under the same difficult conditions.

The old dam has been much maligned, being condemned by experts in sentiment and psychology as being dangerous on account of its slender appearance, while in fact, when the stresses are computed in the light of more recent investigations, it is found to be a very substantial dam, and much respect is due to the builder, F. E. Brown of Los Angeles. The old dam has a factor of safety against crushing under the direct water load of 7.5, allowing the ultimate crushing strength of granite to be 4000 lb. per sq. in. The new dam has a like safety factor of 13.5, allowing the ultimate crushing strength of concrete to be 3000 lb. per square inch.

The multiple arched design of dam is an amplification of the arch principle in structural dam design, in which advantage is taken of the water pressure to assist the weight of the structure to get the required stability. There are none other than compressive stresses in the multiple arched dam when the loading, as in the present case is moderate in amount, the nearest to a tensile stress being that of the bending due to rib shortening at the

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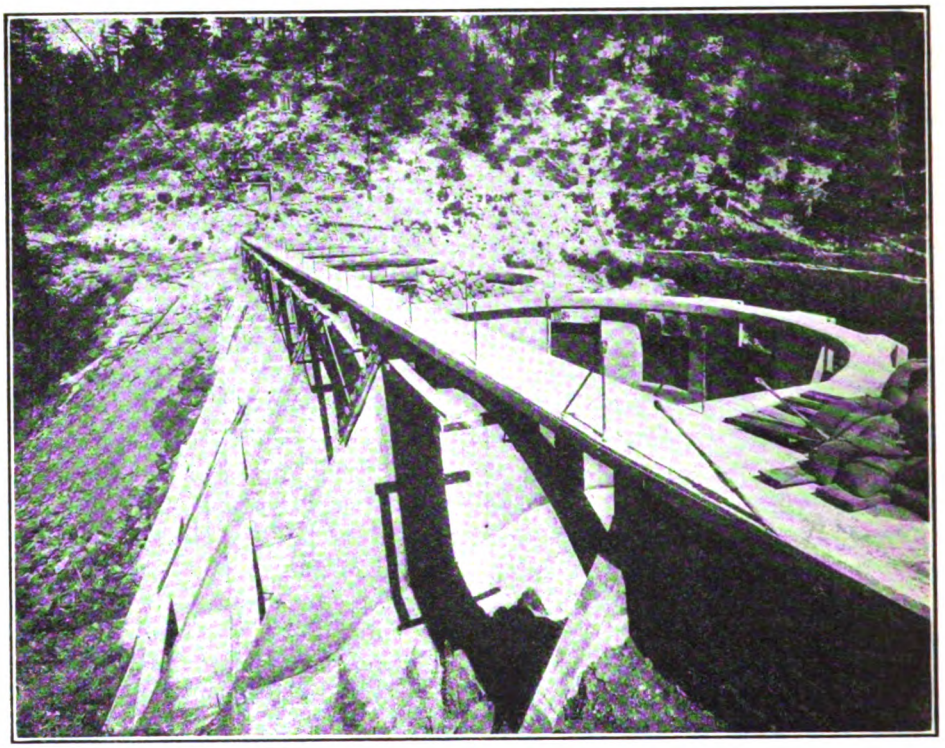
spring lines of the extrados, and at the crown line of the intrados, but these eccentric loadings, owing to the light unit loadings adopted are well within the requirements of good practice.

The front and rear views of the dam in service were taken in June 1913, at which time the writer made a careful inspection of the dam. It was gratifying to learn that there was to be found no visible crack in the entire structure, and that the walls were practically watertight throughout. The slight leakage showing came through the seams of the bed rock, which seams have not yet silted tight by reason of the exceptionally clear condition of the water.



VIEW SHOWING SPILLWAY DETAILS, STRUT MEMBERS, AND WALK.

Structural Geology South of the Santa Susana District

By CLARENCE A. WARING*

ON account of the recent development of oil territory north of Santa Susana, the structure of the country south of the region is of considerable interest. The following notes are based on a field study of the region, and a critical laboratory study of the fossils. The author is indebted

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to the Stanford Geological Survey of 1910 for the use of their fossil collections and areal geologic map. The cross-section (Fig. 1) is taken from the south side of Simi valley in a southeast direction to the coast. The structure may be divided into three portions.

1. A broad syncline of the Monterey formation covers the central part. It consists of about 6000 ft. of fine-grained diatomaceous shales of a light buff color. This formation is usually unfossiliferous, and is covered by alluvium in the San Fernando valley. The Vaqueros formation underlies the Monterey and is exposed both to the north and south. It is made up of about 12,000 ft. of quartzitic sandstones and clayey shales which are fossiliferous in

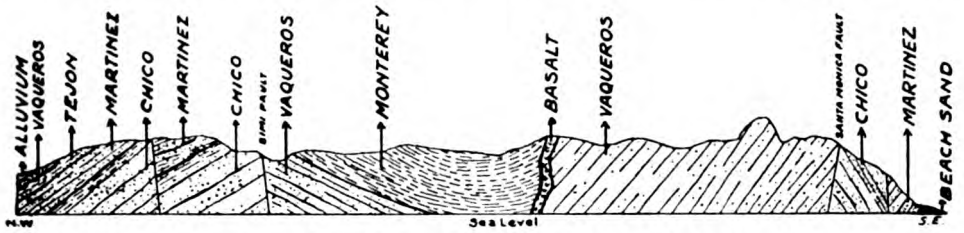

FIG. 1. CROSS-SECTION, SOUTH SIDE OF SIMI VALLEY.

places. This large central area is faulted both to the north and south, such that the older sediments of Eocene and Cretaceous age are brought into contact with the later Miocene sediments.

The Eocene can be divided into a lower (Martinez) and an upper (Tejon) member. The Martinez consists of about 2000 ft. of coarse conglomerate, buff fossiliferous sandstone, and shale. The Tejon consists of over 800 ft. of conglomerate, shales, and sands, and is probably to be correlated with the Topa Topa formation. The full thickness of Tejon is not exposed on the south side of the Simi valley.

The Upper Chico (Upper Cretaceous) consists of over 8000 ft. of unfossiliferous gray granitic sandstone, overlain by about 200 ft. of shales. It is underlain by fossiliferous Chico sandstone.

2. The northern part of the region is cut by two faults. The smaller of these runs approximately east and west and runs into the main Simi fault to the east. This double faulting has caused a repetition of the Upper Chico and Eocene strata. The secondary fault had its downthrow on the south side, and a large area of Eocene dropped down into a position where it was less exposed to erosion than that to the north of the fault, where the tops of the Simi hills have been eroded down to the Chico sandstone. In this way the thick conglomerate beds at the base of the Eocene are offset about two miles on the surface exposure. The beds dip at an angle of about 20° and differ about 900 ft. in present elevation. In order to produce such a horizontal difference, the vertical displacement must have been in the neighborhood of 3000 feet.

3. The faulting in the southern part of the area has brought the Chico up against the Vaqueros. The Martinez has dropped down into contact with the Chico. This part of the area has been a region of volcanic flows and intrusions.

The structure is probably not favorable to the accumulation of oil, but the region is one of good exposures and is useful for geologic correlation with areas which are favorable but have few good exposures, of the lower Eocene and Cretaceous sediments especially.

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The Engineering Digest

Extinguishing Fires in Oils and Volatile Liquids*

By EDW. A. BARRIER

THE extinguishing of fires in oils and in most of the volatile liquids has always been a difficult problem, and where fires of this kind occur the results are frequently very disastrous. Our most common extinguishing agent, water, works rather unsatisfactorily upon the majority of such fires, but it is still the only one available where heroic measures are required. Comparatively recently, however, there have been two or three other materials introduced for use as extinguishers which have shown some promise for dealing with these fires, and it is the purpose of this paper to discuss these materials and the conditions under which they prove the most efficient.

Not all fires in volatile liquids are difficult to handle with water. When the liquid is miscible with water, this extinguishing agent can be successfully used. Examples of this kind are denatured alcohol, wood alcohol, grain alcohol, acetone, etc. Where the liquid is not miscible with water, little or no effect is produced except to wash the burning liquid out of the building where it may be completely consumed, or, if the quantity of oil is small, possibly to extinguish the fire by the brute cooling effect of a large quantity of water sprayed upon the fire. Soda and acid extinguishers are somewhat more effective than pure water, but even they fail under most conditions. The various grenades containing salt solutions which were formerly extensively exploited are, of course, practically worthless.

The only principles that can be made use of in extinguishing fires in volatile oils are: (*a*) to form a blanket either of gas or of solid material over the burning liquid which will exclude the oxygen of the air; or (*b*) to dilute the burning liquid with a non-inflammable extinguishing agent which is miscible with it.

To the blanketing type of extinguishers belongs sawdust. Paradoxical as it may seem, ordinary sawdust is an excellent extinguishing agent for certain volatile liquids, especially those of a viscous nature. A considerable number of experiments were conducted in the fall of 1912 by the inspection department of the Associated Factory Mutual Fire Insurance Companies, in the extinguishing of fires in lacquer and gasoline in tanks with sawdust, and the results were surprisingly satisfactory.

The liquids were placed in three tanks 30 in. long, 12 in. wide, and 16 in. deep; 48 in. long, 14 in. wide, and 16 in. deep; and 60 in. long, 30 in. wide, and 16. in. deep. The sawdust was applied with a long-handled, light but substantially built snow shovel having a blade of considerable area. In every case the fires were extinguished readily, especially in the two smaller tanks which were about as large as any ordinarily employed for lacquer in manufacturing establishments.

The efficiency of the sawdust is undoubtedly due to its blanketing action in floating for a time upon the surface of the liquid and excluding the oxygen of the air. Its efficiency is greater on viscous liquids than on thin liquids, since it floats more readily on the former than on the latter. The sawdust itself is not easily ignited and when it does become ignited it burns without flame. The burning embers have not a sufficiently high temperature to reignite the liquid.

The character of the sawdust, whether from soft wood or hard wood, appears to be of little or no importance, and the amount

*Abstract from *Journal* A. S. M. E., November 1913.

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of moisture contained in it is apparently not a factor, so that the drying out of sawdust when kept in manufacturing establishments for a time would not affect the efficiency.

It was found that the admixture of sodium bicarbonate greatly increased the efficiency of the sawdust, as shown both by the shortened time and the decreased amount of material necessary to extinguish the fires. A further advantage of the addition of bicarbonate of soda is that it decreases the possible danger resulting from the presence of sawdust in manufacturing plants, since it would be difficult, if not impossible, to ignite the mixture by a carelessly thrown match or any other ready source of ignition.

Although the efficiency of the sawdust is greatest on viscous liquids such as lacquers, heavy oils, japan, waxes, etc., in the tests referred to, fires were extinguished in gasoline contained in the smallest tank and also when spread upon the ground. In larger tanks the sawdust or bicarbonate mixture does not work so well, since the sawdust sinks before the whole surface can be covered, whereupon the exposed liquid reignites.

In recent years carbon tetrachloride has received considerable attention as a fire-extinguishing agent. This is due largely to the activity of certain manufacturers of fire extinguishers which use liquids, the basis of which is carbon tetrachloride.

This substance is a water-white liquid and possesses when pure a rather agreeable odor somewhat similar to chloroform. A considerable proportion of the commercial article upon the market, however, contains sulphur impurities which impart a disagreeable odor to the liquid. The substance is quite heavy, its specific gravity being 1.632 at 32°F. It is non-inflammable, non-explosive, and is readily miscible with oils, waxes, japan, etc. When mixed with inflammable liquids it renders them non-inflammable provided a sufficient quantity is added. Its vapor is heavy, the specific gravity being about 5½ times that of air, consequently it settles very rapidly. As an extinguishing agent it operates by both the principles mentioned above; namely, it dilutes the inflammable liquid rendering it non-inflammable, or at least less inflammable, and it forms a blanket of gas or vapor over the burning liquid which excludes the oxygen of the air.

Although this paper is confined to a discussion of extinguishing fires in oils and volatile liquids, it may not be out of place to mention that the claims made by certain manufacturers producing extinguishers which use liquids, the basis of which is carbon tetrachloride, are grossly exaggerated. These preparations, none of which is more efficient than carbon tetrachloride, are not the equivalent of the ordinary water extinguishers for general use on such materials as cotton, wood, paper, oily waste, etc.

On volatile liquids, oils, etc., carbon tetrachloride has, however, shown very satisfactory results under some conditions, but the readiness with which a fire can be extinguished with it depends to a considerable extent upon the skill of the operator and the nature of the fire. In tank fires the length of time that the liquid has been burning is an important factor, and in such cases where the sides of the tank become heated the only way in which the fire can be extinguished is to squirt the liquid forcibly at the sides. If the carbon tetrachloride is squirted directly into the liquid it is much more difficult, if not impossible, to extinguish the fire.

The height of the liquid in the tank is also a very important factor. Where the liquid is low the sides form a pocket which retains the vapor and aids considerably in smothering the blaze. When the tank is nearly full, however, this condition does not exist, and it is then very difficult, if not impossible, to extinguish a fire in a highly volatile liquid, such as gasoline; only the most skilled operators are successful in these cases. The size of the tank or the extent of the fire if upon the floor is, as would be expected, of considerable importance. In tanks larger than about 28 by 12 in., more than one extinguisher and operator working at a time are necessary to extinguish a fire in such materials as gasoline. In one test where a tank 60 by 30 in. was used, no less than seven operators were necessary, and even then it was only with the greatest difficulty that the fire was put out.

All of the above remarks apply to carbon tetrachloride in the ordinary one-quart extinguisher as generally sold. It is probable that a larger extinguisher which could throw a large stream would prove more efficient, but on account of the great weight of carbon tetrachloride such an extinguisher would have to be specially designed to make it readily portable by mounting on a truck

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or some similar means. Expelling the liquid by means of a hand-pumping arrangement would probably be unsatisfactory, and it would therefore be necessary to force it out in some other way.

A few systems have recently been installed in which an elevated tank containing carbon tetrachloride was connected with automatic sprinklers or perforated pipes placed in hazardous rooms where volatile and inflammable liquids are in use. So far as is known, none of these systems has as yet been called upon to extinguish a fire, but there appears to be no reason why such a system should not provide excellent protection in special cases. In such systems it would be necessary to consider the safety of the workmen and furnish ready means of escape, since carbon tetrachloride is an anesthetic and where thoroughly sprayed through the air, as from an automatic sprinkler, it would probably produce rapid results.

The nature and effect of the fumes given off when carbon tetrachloride is thrown upon a fire is a subject which has received a great deal of discussion. When the liquid comes in contact with a fire the vapor is partly decomposed, resulting in the evolution of a considerable quantity of black smoke which is undoubtedly finely divided carbon. Pungent gases are also produced which appear to be mostly hydrochloric acid with possibly a small amount of chlorine. Since carbon tetrachloride contains no hydrogen from which hydrochloric acid could be formed, this substance must be produced by the action of chlorine on the gases arising from the burning material or upon the moisture of the air.

The fumes of carbon tetrachloride, although of a very pungent nature, do not produce any permanent injury under ordinary conditions where the operator can make his escape after he has inhaled all that he can stand, but they are a distinct handicap in fighting a fire and are one of the objectionable features to carbon tetrachloride as a general fire-extinguishing agent. In large rooms, or where a small quantity of carbon tetrachloride is sufficient to extinguish a fire, the gases are, of course, less objectionable.

Another method of extinguishing fires in oils and volatile liquids which has recently been proposed and experimented with is that of using frothy mixtures. The idea seems like a very promising one and the tests which have been thus far reported indicate very satisfactory results. The idea was originated and has been developed in Germany. So far as is known no experiments have been conducted in this country.

The process consists essentially in causing two liquids to mix in a tank where foam is produced. The tank is made air-tight and sufficiently strong to permit of the foam being forced out by carbon dioxide under pressure, and the foam is conveyed to the fire by means of a line of hose. The exact nature of the liquids has not been disclosed, but one of them probably consists of a sodium carbonate solution containing froth-forming ingredients such as glue or casein and the other an alum solution. The two on coming together generate carbon dioxide, which produces froth.

This froth is reported to be quite stiff and to shrink in volume but a comparatively small amount even after a period of half an hour.

A number of tests were conducted in the winter of 1912 in Germany; some of them on a considerable scale. In one case as much as five tons of crude naphtha in a tank was involved, and in another an area of 1300 sq. ft. of burning tar was used. In all cases the results were reported satisfactory, the fires being extinguished in a short time.

The frothy mixture undoubtedly owes its efficiency to its blanketing action in settling upon the surface of the burning liquid, thus excluding the oxygen of the air, and to the fact that the bubbles of liquid contain carbon dioxide which upon bursting produce an atmosphere in which combustion cannot take place.

According to the latest reports, the matter is still in an experimental stage, various details regarding the form of apparatus, most efficient pressure, and design of nozzles being under consideration; but from what has already been done it would appear that the idea is a very promising one, and that this method of extinguishing fires in oils and volatile liquids will prove to be by far the most efficient of any that has as yet been suggested.

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Diesel Oil-Engine Operation*

By J. W. DAWLEY

THE experience I have had in the operation of oil-engines is limited to the single installation in our plant at Hugo, Oklahoma. I will give only such information or data as we have upon the operation of this unit:

In November 1911 we completed the installation of a 225-hp. Diesel oil-engine in our plant, and began operations in that month. This engine is direct connected to a 200-kva. Fort Wayne generator.

We have operated this unit continuously 24 hours per day (excepting Sundays) up to the present time. We shut down on Sundays from about 8 a.m. to 4 p.m., to look over the equipment or make any necessary adjustments. Up to the present time we have never had to shut this unit down during operation for any fault of the engine. Our load varies from 70 to 250 hp., the greatest load we have carried on this being 250 horse-power.

We operate a small 100-kva. belted steam unit during the hours on Sunday that the Diesel is shut down, and in parallel with it over our peak load. Owing to this fact, and that our switchboard is not equipped to register the output separately on these units, we are unable to give an absolutely accurate account of the fuel cost per kilowatt-hour on the oil-engine alone. However, from tests made for a short period of time, or a few days' run, at different intervals, we have estimated this cost to average about 2½ to 3 mills per kilowatt-hour, the price of fuel oil varying from $1.17 to $1.80 per barrel. For the year ended October 31, 1911, our total fuel cost, operating altogether with steam units, was $6364, with a gross revenue of $23,000. For the year ended October 31, 1912, our total fuel cost for oil was $2168, for coal $990, a grand total of $3158, with a gross revenue of $27,200; there was an increase in load for 1912, also a reduction in rates.

The steam unit was operated during this period approximately 1500 hours, and the oil-engine 8200 hours. The consumption of lubricating oils is about the same as on a steam unit of equal size.

The first filling of the crank case required about 20 or 25 gal. of oil; while running we use approximately 2 gal. per 24 hours. We empty the crank case and clean it out and renew this oil entirely about once every three months; this, however, will depend upon the quality of oil used, the heat of the engine, which depends upon the load, and the temperature of the engine-room.

We use a cylinder oil, which costs us now 28c. per gal. delivered at the plant. The average amount of water used in the crank case with the oil is about 5 gal. per hour.

For the cooling system, the amount of water used per 24 hours is approximately 5000 gal.; the temperature of this water at intake is about 60°, and it leaves the engine at about 100 to 140°.

The regulation on the engine is good, being within the 3% guaranteed by the builders.

The total cost of repairs from installation to date has been $158.33; the major portion of this was for replacement of exhaust or manifold tees and pipe, and overflow water piping, these being put in this past winter; the old ones were eaten through from the action of the hot water and the sulphur in the fuel oil.

The depreciation is very little, the only apparent wear being mentioned above. Only one man is required in attendance, and his duties are very light; one man should be able to take care of two or three of these units very easily. For the water circulation system we use a small centrifugal pump direct connected to a 1-hp. motor, and cool the water over the cooling tower used in the ice department. Where a plant does not have this advantage, a small cooling system has to be supplied. The total installation cost of our equipment, including everything excepting buildings, was $22,715.

*Read before the Gas, Electric & Street Railway Association of Oklahoma, May 6, 1913.

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Boiler-Feed Pumps

By ALFRED WILLIAMS

IN most of the small central stations throughout the country the time-tried and time-honored simple reciprocating pump for boiler-feed purposes still holds sway, although in newer stations the compound steam-end reciprocating pump is used for the higher boiler pressures employed; but even the latter is fast giving way before the steam-turbine-driven or motor-driven centrifugal pump. This change has not been forced owing to any superior economy on the part of the latter unit, but because of its easier operation and lower maintenance cost. There is considerable room for improvement in those stations equipped with the simple reciprocating pumps, especially where the latter call for some 200 to 300 lb. of steam per indicated horse-power. If steam must be used, it would be preferable to employ an independent steam engine which will operate at, say, 60 lb. of steam per indicated horse-power. An argument frequently brought out by persons who oppose the use of electric motors for driving boiler-feed pumps is that the motor does not offer sufficient variation in speed to meet ordinary conditions of practice without introducing resistance in the circuit. It is possible that very much energy might be wasted in this manner, and yet a great saving can be shown over the inefficient direct-acting steam pump. It has been suggested that instead of the single direct-acting steam pump a triplex pump be installed, and that this pump be driven by a constant-speed motor or belted from the main engines. The variations in the rate of pumping can be taken care of by placing a by-pass valve in the suction to the exhaust of one or two of the pump cylinders. Then to vary the rate of pumping it would only be necessary to open the by-pass valve more or less. With the by-pass valve shut the pump works at maximum output. By opening the two by-pass valves wide the rate of pumping in a triplex pump would be reduced two-thirds. Such a pump would be most economically driven from the main engine shaft. The advantages and economy of using motor-driven or turbine-driven centrifugal pumps for feeding boilers are, however, too great to be ignored.

Among the points in favor of the centrifugal pump are the following: It has neither suction nor discharge valves; it possesses only one moving part, which is in continuous rotary motion, and it delivers the water in a constant stream in contrast with the intermittent impulses of the ordinary duplex pump so widely employed for this class of service. Since the stream of water is constant and without impulses, there is no vibration in the pipes, and there is little chance for scale to deposit in them. The pump, moreover, possesses all the advantages of being valveless. There are, therefore, no plungers to be packed, no steam valves to reseat, and no pistons to require new rings from time to time. A feature of the pump which is paramount is that when running at constant speed it delivers water at a certain pressure, which it cannot exceed by more than a few per cent, even though the delivery pipe be completely closed. With the reciprocating pump the latter calamity usually means a broken pipe or pump. This feature of the centrifugal pump makes it possible for a fireman to shut off the feed to any of the boilers or to all of the boilers without shutting off the pump, which in many plants would entail leaving the boilers and going to another part of the station. It is thus possible to feed the boiler automatically by installing a ball-float for each boiler, which would control a balanced valve in the feed pipe. This makes it unnecessary to have connections with a line supplying steam to the pump, as the latter runs continuously whether any of the boilers are being fed or not. This method of automatic feeding makes the boilers independent of each other, and makes it unnecessary for the water line in all the boilers to be at the same level. This latter feature is important in stations containing several sizes of boilers or where some are of the vertical type and some of the horizontal type. It might be contended that the efficiency of a centrifugal pump operating under these circumstances would be very low when supplying only a small portion of its rated output, and that it would consume power when merely turning the water without delivering any. This objection in the case of a motor-driven centrifugal pump is of little moment.—*Electrical World.*

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Discussion

Road Construction

The Editor:

Sir—The entire theory of roadway construction has completely altered in the past ten years because of the change of traffic conditions. Before the advent of the automobile truck, ordinary traffic was of from 2 to 3 tons as a maximum, but with the high-power motor carriages of today, 5 to 10 tons are common, and if roadways were properly constructed these limits would be exceeded.

The entire success of a roadway depends on the sub-base, and as earth materials have to be removed by cuts or fills for all roadways, this portion of the work is the same for all classes of construction.

No specifications have ever been written that adequately fill the requirements for a perfect sub-base, the replacing of earth has never been successful, and because of this fact the roadway base of itself becomes of much greater importance than if the ordinary means of preparing a sub-base were successful. Earth on a sub-base cannot be puddled and rolled, and while this method is used for all trenches, it has not been found successful in completely filling the void of a trench. Engineers follow the general rule on all sub-grades, and of course it is impossible to secure any method different from that in general use.

The question of the base is of the greatest importance to the successful construction of every roadway, because of the imperfections of any sub-grade, and a base that will bridge and sustain loads over the void places of the sub-grade is an absolute necessity to the continued wearing of a roadway under the extreme traffic conditions of this day, and for this reason practically every engineer in this country provides for a firm base of concrete, and it is safe to state that 95% of all permanent road construction, including in this term street pavement, planned in the past ten years have had as a first requisite a concrete base of varying thickness, the general rule being for not less than 5 in. of a lean mixture. No other base has been found successful, and while some failures have been recorded of concrete, there have been none that vitally affect the roadways.

Under the conditions existing in California as of labor cost of materials, etc., a concrete base can be constructed at a cost of 7c. per square foot. These figures are for a 5-in. base on the usual specification of 1 part portland cement, 3 parts graded sand, and 6 parts rock. This mixture is the one in general use and has sufficient stability for all general traffic conditions. A large number of roadways have been constructed of a still leaner mixture, 1 to 10 and 1 to 12 having been used with good results. No other base possesses any of the advantages that concrete gives. The best authorities agree that concrete increases in strength from the time of its initial set, and that a period of years from 50 to 65 will elapse before the concrete comes to its ultimate strength. Every other base used in roadways decrease in strength, from the time they are first laid, and particularly is this true of the construction commonly known as asphalt concrete, as the cementitious properties of asphalt decrease from volatilization under every condition.

The question of wearing surface is the only one that remains to be considered for roadways, and in the past five years a great number of the leading engineers of the country have done away with any wearing surface except that of the concrete itself, and unquestionably this will be the last word in road construction, as there is really no good reason for any wearing surface other than that which can be made by a proper treatment of concrete, as this material lends itself to being roughened, and provides an ease of traffic equal to any of the bituminous wearing surfaces.

Macadam roadways have been popular because of their low first cost in many sections of the country, but with the enormous production of portland cement and its cheapness, there is no reason why macadam in any form should be used for a roadway, as the addition of cement to rock and sand makes a permanent roadway at a slight advance in the cost over macadam. If macadam should be used at any place it should never be less than 10 in. thick, and then on a Telford foundation consisting of cobbles from 4 to 8 in. diameter. If macadam is properly constructed and of this thickness, the cost of 5 in. of concrete will be less than the macadam. Statistics for the past 35 years carefully compiled show that the average cost of maintenance of water bound macadam roads vary from 3c. per square yard to 15c. per square yard per year, the average cost of maintenance being about 8c. per square yard, and as traffic increases this cost of maintenance must necessarily increase.

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Asphaltic concrete as a base has been given a great amount of exploitation on the Pacific coast for the past three years by the owners of a patent which governs its construction. Asphaltic concrete has no bridging strength and as the sub-grade changes it necessarily follows the sub-grade, and its failures are just as certain as it is certain that the sub-grade is faulty, and a perfect sub-grade is an impossibility. While this form of construction has many advocates, no one honestly claims that it in any measure possesses the advantages of cement concrete. With asphalt at present prices in this state the cost of asphaltic concrete and cement concrete are practically the same. Five inches of asphaltic concrete can be laid for 8c. per square foot, and under no circumstances should it ever be used as a base. It does possess advantages as a wearing surface laid on a concrete base, but the royalty charged by the owners of the patent, which is 25c. per square yard, makes it a high first cost pavement.

There is an asphaltic wearing surface that is coming into general use in different portions of the country that is not covered by the patent spoken of, and which is commonly known as 'Topeka specification.' This asphaltic concrete by six federal court decisions has been held not to be an infringement of the so-called Warren patent.

A 5-in. concrete roadway with a squeegee coating from ½ to ⅝ in. thick, composed of asphalt and stone chips, makes an ideal roadway for every kind of traffic. It is of permanent construction so far as the concrete is concerned. It can be built at a very low cost, as all of the materials are found in close proximity to the highways of every portion of the state. The maintenance cost of the wearing surface is indeterminate, because this form of construction has only been in use for the past four years, but it is safe to say that it can be maintained successfully at a less cost than any other form of roadway having a bituminous wearing surface, and this is in every way an ideal form of construction. It is practically noiseless, nonskidding, dustless, and should last with the heaviest traffic from 3 to 5 years without being resurfaced, and possibly longer, and when it is known that this surface can be applied to concrete at a cost of less than 1c. per sq. ft. the question of the cost of maintainence is a very minor one.

Sheet asphalt as a wearing surface has been the most generally used of all pavements. Of a total of 160,000,000 yd. of pavement laid in the United States since 1870, when the first sheet asphalt pavement was laid by Professor de Smith, about 80% has been sheet asphalt, and each year has seen a large increase in the amount laid and in the per cent of sheet asphalt as to the total amount laid. 98% of all the sheet asphalt pavements in the country is laid on a concrete base, and in no other portion of the country except on the Pacific coast has sheet asphalt been laid on an asphaltic concrete base; in fact 95% of all of the asphaltic concrete base in the United States has been laid on the Pacific coast.

Every roadway must be considered from an engineering standpoint, from the traffic that it will have to sustain, and it is fallacy to construct any roadway with the ever-increasing weight of trucks and loads, which does not possess a permanent base, and the only permanent base is a concrete base. In some cases cement concrete should be reinforced, but in every instance not less than 4 in. of cement concrete should cover the sub-base of every roadway.

A. C. Root.

San Francisco, October 20, 1913.

Hints on Practice

Erecting Pumping Engines

By J. H. BRYAN

As soon as the site is selected for engine foundations, and lines and levels are given by the employed architect, select a convenient wall or column of the building, or, if such is not in existence, plant a 6 by 6-in. post firmly in the earth. On this wall or post chisel the following:

Bench mark for floor line.

Top surface of the foundation.

Thickness of grouting.

Underside of full nut of foundation bolts.

Other important or necessary levels.

A column or wall of the building is preferable for the bench marks for the various levels, as there they can be referred to from time to time in case the foundations settle and throw the engine out of alignment.

Foundation.—The depth of the foundation must be determined by the nature of the soil and the construction of the engines. The minimum thickness of a perpendicular line of foundation for a Corliss engine having

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a capacity of 4,000,000 gal. should be between 7 and 8 ft. When the bottom of the foundation pit is reached and the earth is found to be of a proper consistence, drive a steel bar 2 or 3 ft. beyond the depth of the pit to determine if the ground is solid. If the subterranean foundation is of quicksand or soft earth, it is necessary to resort to piling, spaced about 3 ft. centres, covered with two courses of 3 in. oak plank and laid down with reverse forms.

Assuming that the foundation pit is satisfactory, place the foundation templet in position over the supporting timbers and level the bottom of the templet to the bench mark indicating the top of the foundation. Adjust the foundation bolts to the under side of a full nut to bench marks. Make boxes of rough lumber to fit around the nut-keepers to foundation washers of plates in order to keep the concrete from interfering with the adjustment of the bolts. The tubing of the pipes, or wood boxes, encircles the bolts and extends from the plates to the under side of the templet, and is held tight to the templet by adjusting the nuts to the foundation bolts opposed by temporary washers, made of wood, from the upper side of the templet to the nuts.

Material for concrete should be a high-grade portland cement, coarse sand, and gravel, free from loam, mixed in the proportion of one of cement to three of sand and gravel. Thoroughly knead to the consistence of mortar, and apply immediately. Care should be taken to avoid air pockets by frequently tapping the concrete while in a soft state. From a week to ten days should be allowed for the foundation to become hardened before the engine is mounted thereon.

Mark the centre and cross-lines on the foundation walls from the templet, as these lines will be handy in locating the engine frames.

Leveling the Main Engine Frames.—After placing the engine on the foundations, proceed to level them to the bench marks, making allowance for the proper thickness of the grouting. This should not be less than ¾ in. In leveling the main engine frames and the suction bases to the water ends, employ the following leveling points and spots:

The bored surface of the main shaft bearing shells.

The finished pad immediately near the pillow block.

Four spots on the suction bases.

The main frames are located first, using a straightedge across the flanges nearest the water end. Great care must be taken to have the ends of the frames aligned accurately, as the whole alignment of the engine depends upon the ends of the frames being at right angles to the centre line of the engine frames and the rest of the parts. Tram spots are placed at each end of the frames near the flanges, and trams for pitch and diagonal centres are provided in the tool outfit. These trams are made to check for parallelism of the frames, and are fitted to prick punches in tram spots on the frames.

Before grouting, have the members on shims, leveled and aligned. Avoid the unsightly appearance of wedges protruding from parts of the engine.

The Assembling.—Erect the crankshaft to prove alignment, by crankpins, to the line in the centre of the engine frames before grouting. The proportions of grout should be half cement, high-grade portland, to half coarse lake sand free from loam, and mixed to the consistence of paint. Prepare a dam 6 in. from the castings and around the parts to be grouted. In the process of pouring the grout use a thin lath to assist in filling between foundations and castings.

Put crossheads in place, assemble connecting rods, stretcher rods, pistons, and plungers. Put engine on extreme stroke and make witness marks on some convenient portion of the engine, preferably the guide section and near the centre of the crosshead, to assist in determining the piston and plunger clearance. Disconnect the crosshead wristpin and pry the whole outfit to contact nearest the heads. Refer to the witness marks on the guide sections and crossheads for proper clearances. Replace crosshead wristpin, turn the engine over to the opposite centre, and repeat the foregoing operations, and refer to witness marks.

The operation of moving the engine from one centre to the other for piston clearances must not be done with steam; use hand gear. —*American Machinist.*

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Engineers' Note Book

Power Required for Belt Conveyors

THE following formulas for calculating the power required for belt conveyors are given by Reginald Trautschold in the *Canadian Engineer*:

W = Weight of load handled in tons per hour (capacity).
V = Velocity (speed) of conveyor in feet per minute.
L = Length of conveyor in feet—distance between end pulleys.
H = Height to which load is elevated in feet (incl. conv.).
= Difference in elevation in length of conveyor.
w = Width of belt (conveyor) in inches.
W′ = Weight of load handled per minute per foot of conveyor in pounds.
= 2000 W/60 V.
W_d = Weight of moving parts of conveyor (belt) per foot in pounds.
= 0.7425 w.
f_s = Speed factor.
= 0.004 w—from experiment.
f_r = Load factor.
= 0.080—from experiment.

Horsepower required to run conveyor empty:

$$= \frac{W_d \times f_s \times V \times L}{33{,}000} \quad \frac{0.00009\ w^2 VL}{1000}$$

Horsepower required to convey load:

$$= \frac{W' \times f_r \times V \times L}{33{,}000} = \frac{0.08\ WL}{1000}$$

Horsepower required to elevate load (incl. conveyor):

$$= \frac{2000\ W \times V \times H}{60\ V \times 33{,}000} = \frac{WH}{1000}$$

Then, total horsepower required:

$$Hp. = \frac{(0.00009\ w^2 V + 0.08\ W)L + WH}{1000}$$

Additional horsepower required for each tripper or fixed dump:

$$Hp. = \frac{(w-10)}{8}$$

(Conveyors 12 in. to 36 in. inclusive.)

APPROXIMATE amount of filler required in cubic yards per 100 ft. of road for crushed stone macadam bottom courses in different widths and depths using 0.35 cu. yd. of filler per cubic yard of rolled bottom is given in the 'Highway Engineers Hand Book,' by Harger and Bonney, in the following table:

Width of macadam, feet.	Rolled depth bottom course, in.: 3	4	5	6
10	3.2	4.3	5.4	6.6
12	3.8	5.1	6.5	7.6
14	4.5	6.0	7.5	9.0
15	4.9	6.4	8.0	9.9
16	5.2	6.9	8.6	10.4
18	5.9	7.9	9.7	11.8
20	6.4	8.6	10.8	12.8
22	7.0	9.4	11.8	14.2

THE power lost by skin friction in centrifugal pumps is given by Carl George de Laval as follows:
W = power due to resistance in foot-pounds.
n = revolutions per minute.
h = head in feet.

$$W = 8132 \times \frac{1}{n^2} \times h^{2.5} \text{ foot-pounds.}$$

BOTTOM and mean velocities in feet per second for the transportation of various materials by water in channels are given by Mansfield Merriman in the following table:

	Bottom velocity.	Mean velocity.
Clay fit for pottery.....	0.3	0.4
Sand size of anise seed....	0.4	0.5
Gravel size of peas.....	0.6	0.8
Gravel size of beans.....	1.2	1.6
Shingle about 1 in. diam..	2.5	3.5
Angular stones about 1½ in. diam.	3.5	4.5

RECENT experiments on the flow of air through smooth sheet steel ducts varying in size from 12 in. to 48 in. diam., at velocities ranging from 1000 to 2400 ft. per minute, appear to show that the average value of the coefficient of friction is 0.0035.

A FORMULA for the flow of water through 90° V-notch weirs is given by James Thompson as follows: Where H = the height of the notch in inches, the angle of the notch being 90°, cubic feet per minute = $0.305\ H^2 \sqrt{H}$.

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Company Reports

The Monte Cristo Oil & Development Co. held a meeting of the stockholders on October 21 to consider a proposition for the creation of a bonded indebtedness of $400,000. The company has a floating debt of about $250,000, which will be funded by this issue of bonds. The remainder of the money secured will be used in the development of the properties of the company. On February 28 last the contract under which the company was disposing of its oil expired, and since that time the production, which amounts to about 45,000 bbl. per month, has been stored. At present the company has more than 300,000 bbl. on hand. The company was fortunate in that it had the storage capacity to handle its oil in this manner, but it has tied up a considerable amount of money, and it was thought advisable to fund the debt.

The San Diego Home Builders, Inc., has filed an application for a certificate permitting the company to install and operate a water system in the vicinity of Angelus Heights, San Diego county, California.

The Tujunga Terrace Improvement Association of San Fernando, California, has filed a complaint against the Tujunga Water & Power Co., alleging that the company's service is inadequate, and that it is collecting money for water not delivered. The complainant asked that the Tujunga Water & Power Co. be compelled to build a reservoir, to enlarge its plant, and to take all steps necessary to furnish the complainant with a sufficient supply of water at reasonable rates.

The California Railroad Commission has rendered a decision granting authority to the Halfmoon Bay Light & Power Co. to change rates for agricultural and power purposes. The new rates call for a flat charge of $1 per horse-power, with an extra charge of 2½c. per kilowatt-hour. In such cases as this increase in rate after the power company had induced farmers to abandon the use of gas-engines, the company is required, under the terms of the Commission's decision, to replace such gas-engines upon the request of consumers. The Railroad Commission issued an order extending to December 31 the effective date for the issue by the Halfmoon Bay Light & Power Co. of capital stock previously authorized.

The California Railroad Commission has granted authority to the Napa Valley Electric Co. to purchase the property of the Calistoga Electric Co. and to issue $20,500 bonds, $15,300 stock, and $5000 notes. The proceeds from the sale of the securities are to be used to take over the Calistoga properties and to provide for extensions and improvements in the company's facilities. The order allowing the purchase of the Calistoga properties states that the company will make rate reductions in the territory now served by the Calistoga company.

The Spring Valley Water Co. has filed an application with the California Railroad Commission for authority to issue $1,000,000 of two-year collateral trust gold notes to bear interest at 5½%. The company asks also for authority to pledge as collateral security for these notes its 4% bonds in the sum of $1,334,000. The application states that the company expects to realize from the sale of its notes $980,000, and proposes to use the proceeds to pay off existing floating indebtedness. The application also states that $5000 of this sum will be used in payment for work upon the Calaveras dam in Alameda county.

The California Railroad Commission has issued an order dismissing, upon request of the applicant, the application of J. W. Bloom to sell and of the City & Suburban Investment Co. to purchase the water-distributing system serving a portion of Daly City, San Mateo county.

E. M. Wilson, Nettie B. Harris, and Lawrence A. Wilson have applied to the California Railroad Commission for a certificate of public convenience and necessity to construct an electric system in Modoc and Lassen counties.

The California Railroad Commission has granted authority to the San Diego Home Telephone Co. to issue $150,000 in promissory notes. The money is to be used to refund existing indebtedness and to make extensions of the company's system.

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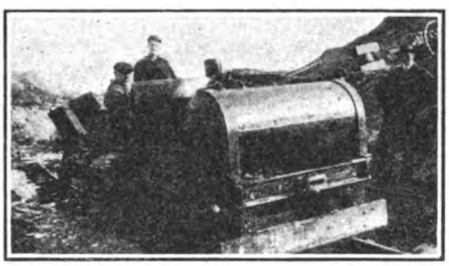
Industrial Progress

Oil-Burning Contractor's Locomotive

The Bell Locomotive Works, of Yonkers, New York, has developed a light haulage steam oil-burning locomotive that is being manufactured in sizes from two to five tons. This locomotive has been designed to meet the requirements of the contractor who wishes to haul his materials at the lowest possible cost and with the least



chance of delay. The good features of the gasoline and electric locomotive have been combined with the simplicity and reliability of the steam-engine, thus making a locomotive that should appeal to contractors interested in the light haulage problem.

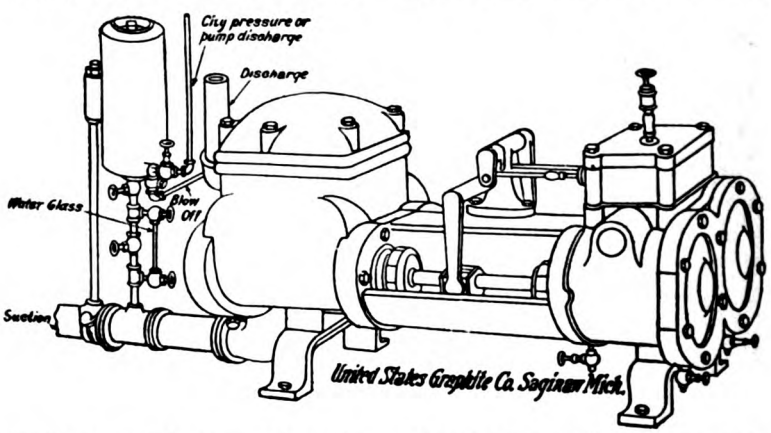
The fuel in any haulage project is, of course, an important item, and the choice of either a gasoline or crude-oil burner is offered in the Bell locomotives. This makes it possible for the contractor who is situated near oilfields to use the crude oil burner and procure his fuel at a very low price.

The accompanying illustration shows one of the 3½-ton locomotives purchased by A. Guthrie & Co., of St. Paul, Minnesota, for tunnel work in Montana. As shown in the illustration, the machine is very compact. It measures 9 ft. in length and 56 inches in height. It exhausts no smoke or gases and has a practical speed of from 15 to 20 miles per hour. The engine is of the two-cylinder, high-pressure, double-acting locomotive type. It is built in one unit, one end being geared to and supported by one main axle, while the other end is hung from the main frame by a flexible steel strap.

A Satisfactory Feeder for Boiler Graphite

The illustration shows a graphite feeder which is recommended by the United States Graphite Co., of Saginaw, Michigan, to accomplish a steady gradual feed.

This feeder has a reservoir which is so equipped with valves that it may be entirely closed and all water pressure shut off. The water valve is then opened so that the ordinary city water pressure is applied to the reservoir of the feeder and then this combination of water and graphite is fed through an outlet valve at the bottom of the reservoir into the feed water on to the suction side of pump. This valve, permitting the water saturated with graphite to pass through, can be readily adjusted by watching the water glass to see how fast it is traveling. With a little experience the engineer soon becomes able to regulate this valve so that there will be, through the hours of operation, a constant leaching of graphite going in to the boiler with the feed until the contents of the reservoir become exhausted, when the valves are again closed and, by means of a drain valve which is on



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the reservoir, it is emptied of the clear water remaining in it and then again filled with graphite and regulated as before.

After a little experience and measuring of time the valve through which the graphite passes into the feed water can be set and marked so that the engineer will know just where to open it each time in order to give his dose as specified. The illustration shows the manner in which the feeder is connected with the feed line at the suction side of pump.

Book Reviews

OIL PRODUCTION METHODS. By Paul M. Paine and B. K. Stroud. Western Engineering Publishing Co., San Francisco. P. 240. Index. For sale by *Western Engineering*, San Francisco. Price $3.

Without disparagement to Sir Boverton Redwood or Beeby Thompson, this work may be rightfully termed as the first publication that considers the subject of petroleum production from the standpoint of the man in the field. It is a practical treatise rather than a statistical review, and as such more nearly deserves to be designated as 'a long felt want' than any other technical publication that has appeared for many years. Heretofore definite knowledge concerning petroleum production methods has been a commodity existing only 'under the hats' of a comparatively few men, and transmitted by observation and word of mouth. Trial and error constitutes the sole means of solving the many problems in the oilfields, and it is not infrequent that methods proved to be wrong in one field are used in another. In their study of the subject, the authors have brought to bear the happy combination of technical training and many years of practical experience resulting in a work that shows how difficulties may be overcome, not theoretically but practically.

The first chapter treats of the Distribution, Properties, and Uses of Petroleum. In it are given a brief historical review, production statistics, methods of measurement, and the general application.

The second chapter is given to a discussion of the geological indications of the presence of oil, and the organic and inorganic theories of the origin of oil deposits. To the layman this is one of the most interesting chapters in the book and, without being needlessly technical, gives a clear and concise exposition of the subject. The matter on logs and diagrammatic records of wells drilled is exceptionally good and directs renewed attention to the utility of these kinds of data.

The third chapter deals with Rigs and Equipment. In this the standard and rotary rigs and their modifications are discussed in detail. The functions of the various members are described and the methods of setting up are given, including lumber lists for rigs of such sizes as are ordinarily used. A discussion of accessories is also embodied, taking in everything about the well from the various lines and casing to the power plant for operating the drills. The fourth chapter covers Drilling Methods. This is perhaps the most important section of the book and one upon which practically nothing has heretofore been written. After a discussion of the application of the two methods of drilling, the authors take up, with exhaustive detail, the various stages in drilling a well. Numerous special tools to meet unusual conditions are illustrated and described as well as the tools used in ordinary practice.

The Exclusion of Water from the Oil Sands is the subject of the fifth chapter. In this the problem of protecting the oil measures from infiltrating water is treated from the standpoint of the latest methods devised for solving this vital problem. It is no less important that the oil supply shall be protected than that it shall be developed, and operators are beginning to realize the significance of this fact. All of the methods in vogue are treated in detail.

The chapter on Production begins with bringing in the well, and after a brief discussion of gushers, takes up the question of pumping in all its phases. Dehydration is also discussed, giving descriptions of the various methods employed and the results achieved by each.

Fishing Tools and Methods is a subject by itself, and as such is worthy of special attention. It has been the cause of much wonderment that drillers seem to be possessed of some sixth sense whereby they diagnose complications existing at the bottom of a hole 3000 ft. deep and then devise remedies for their correction. The marvelous ingenuity displayed in the design of fishing tools for various purposes is clearly shown, and the line drawings used to illustrate the explanatory matter add much to the value of the subject matter. Many typi-

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cal difficulties are shown together with means for overcoming them.

The final chapter is given to a discussion of accounting systems prepared by W. F. and W. B. Sampson of Klink, Bean & Co. A hypothetical case is assumed and a complete system worked out together with facsimiles of all of the bookkeeping forms employed.

Taken as a whole, this work will prove of genuine service to everyone interested in the oil industry and especially to those men in the field who are actually doing the work. It is practical from cover to cover, wastes no time over propounding theories, but treats of things as they are.

DESIGN OF PLATE GIRDERS. By Lewis E. Moore. McGraw-Hill Book Co., New York. P. 278. Index. For sale by *Mining and Scientific Press*, San Francisco. Price $3.

Since plate girders form the basis of steel bridge construction, it is not surprising that this structural detail is a subject large enough to merit careful study. The author, in addition to an experience of six years as a teacher at the Massachusetts Institute of Technology, has brought to bear his experience with the Massachusetts Railroad Commission in passing upon plans for new structures and inspecting old ones. The material given on deflections is contributed by W. H. Lawrence and has never before been printed for general distribution. The subject matter in general is divided into seven chapters entitled: Stresses in Plate Girders; Rivets; Theory of Plate Girders; Design of Through Plate Girders; Deck Plate Girder Designs; Box Girders; and Shop Hints for Structural Draftsmen. In addition to the above, general specifications for steel railroad bridges are given, together with tables and conventional signs.

FARM GAS ENGINES. By C. F. Hirshfeld. John Wiley & Sons, New York. P. 230. Index. For sale by *Mining and Scientific Press*, San Francisco. Price $1.50.

It has often been a matter of speculative wonder as to how the farmer acquired his knowledge of gas engines. There has been no intermediate choice between the trade catalog of the manufacturer and the highly technical work of the specialist on internal combustion engine practice. While, perhaps, it may be true that the average farmer is not apt to bother about the internal workings of his engine so long as it keeps running, it is also true that there are times when gas engines exhibit the characteristics of a balky mule, and apparently quit work for no other reason other than sheer obstinacy. Mr. Hirshfeld's work deals with the design, construction, and operation of the internal combustion engine in its stock form, such as is ordinarily carried on the shelf, as it were, by the machinery jobber and the hardware merchant. The book is well illustrated and written in plain, simple language, free from needless technicalities and at the same time so clear that there should be no difficulty in arriving at an understanding of the operation of the gasoline engine, if one is willing to take the time to read. The gasoline engine is pressing the horse hard for the position of the farmer's best friend. Nowadays it is the gasoline engine that draws the water from the well, irrigates the crops, plows the field, threshes the grain, and carries the crop to the shipping depot. An understanding of its characteristics, principles of operation, and the function of the various essential details will save a world of trouble and help to make life easier.

HYDRAULIC TURBINES. By R. L. Daugherty. McGraw-Hill Book Co., New York. P. 151. Index. For sale by *Mining and Scientific Press*, San Francisco. Price $2.

This work is intended rather for hydraulic turbine operators than for the designer or hydraulic engineer. It is recognized by the author that as the use of the turbine increases, it is desirable that men in charge of hydraulic turbine power-houses should have at least a fair working knowledge of the characteristics of the machinery that they operate. The data given are therefore chiefly fundamental, and while they may not throw any additional light upon the subject as understood by engineers and turbine designers, at the same time for students and power plant operators, this work will be especially useful, as the author has endeavored to prepare the text in such a way as to make it easily understandable by men who have not necessarily had the benefits of a technical training.

The U. S. Bureau of Mines has published Bulletin 22, 'Analyses of Coals in the United States,' with descriptions of samples collected between July 1, 1904, and June 30, 1910. By N. W. Lord, with chapters by J. A. Holmes, F. M. Stanton, A. C. Fieldner, and Samuel Sanford.

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Engineering News

Petroleum

San Francisco, Cal.—The Standard Oil Co. is said to have purchased the property of the Murphy Oil Co. in the Fullerton field. The purchase price is reported as $4,000,000 cash and a 22% royalty on the total output. The total output is approximately 4000 bbl. per day.——The K. T. & O. Co., one of the Southern Pacific's subsidiaries, will erect two reservoirs made of reinforced concrete for the storage of 1,500,000 bbl. of oil.——Reports of oil shipped in bulk from San Francisco during October are as follows:

Refined to—	Gallons.	Value.
Japan	8,302,000	$ 373,597
China	2,350,000	105,750
Hongkong	2,000,000	90,000
Borneo	1,680,000	75,600
Total refined	14,332,000	$ 644,947
Crude and fuel to—		
Chile	14,811,962	$ 243,695
British Columbia	5,922,000	108,270
Honolulu	5,082,000	86,950
Ancon	3,780,000	67,500
Japan	1,680,000	30,000
Alaska	1,680,000	30,000
Total crude and fuel	32,955,962	$ 566,415
Add refined	14,332,000	644,947
Grand totals	47,287,962	$1,211,362
*October 1912	23,280,224	568,517
Increase	24,007,738	$ 642,845

*Crude and fuel, 15,675,056 gal.; refined, 7,605,168 gallons.

In October 1911 the total shipments were 15,463,000 gal. crude, fuel, and refined, against 11,487,000 gal. in 1910, and all crude and fuel. As an indication of development activity in the Midway-Sunset fields, eight companies have contracted for new wells within the past six weeks as follows: General Petroleum, 1, well on section 32, 31-24; Pacific Crude, 1, section 32, 31-23; Baltimore, 3, section 28, 32-24; Wilkes-Head, 1, section 4, 32-23; C. C. M., 1, section 10, 32-23; St. Lawrence, 2, section 5, 32-23; United Oil, 2, section 20, 31-23; Record Oil, 1, section 28, 31-23. The twelve wells were contracted for at the rate of $5.50 per foot or better. Contract labor alone on these wells will cost more than $200,000, while the material required for their sinking will amount to an additional $300,000 to be spent in the fields. The Indian & Colonial Development, Sue Greenleaf, St. Helens, Northern Exploration, American Oilfields, and Standard Oil Co. are also erecting new rigs.——The Turner Oil Co. has paid its initial dividend of 20c. per share, amounting to $200,000.——The production of the United Oil Co. was increased to nearly $45,000 last month as a result of deepening one of its wells in section 6, 32-23, in the Midway district. The company's well No. 5 is also being drilled to greater depth.——The Monte Cristo Oil Co. is reported to have brought in a new gusher on its property in the Fullerton field. The well flowed at the rate of 20,000 bbl. per day for several hours and then sanded up. Work of cleaning it out has commenced.——The price returned to the Independent Oil Producers' Agency for oil marketed in October was 36½c. per barrel, an advance of 1½c. over prices prevailing last spring.

It is stated in an advance chapter of 'Mineral Resources of the United States' that the average price of casing-head gasoline during 1912 was higher in California than in any other part of the country. The total production in 1912 for California was 1,040,695 gal., valued at $112,502, an average price of 10.8c. per gallon. The total output for the United States for 1912 was 12,081,179 gal., which brought an average price of 9.6c. per gallon.——The Standard Oil Co. has brought in a new 10,000-bbl. gusher in the Coyote Hills section of the Fullerton field. It is stated that the total output of the Standard Oil Co.'s wells in California is 50,000 bbl. per day.——The gusher of the Kern Trading & Oil Co. in the Buena Vista Hills section of the Midway field, which was on fire a few weeks ago, is now under control and flowing at the rate of about 2200 bbl. per day.——It is reported that the Santa Susana Syndicate in the Simi Valley oilfield has brought in its well No. 1 at a depth of 780 ft., flowing at a rate estimated at from 2500 to 3000 bbl. per day. The oil is 37°B.——The California Mohawk Oil Co. has declared its initial dividend at the rate of 12c. per share, payable in six monthly installments of 2c. each. The total dividend amounts to $60,000.——In a report recently issued by the Union Oil Co., the total gross sales for the first nine months of the current year were $15,130,486, an increase of $2,619,580 over the corresponding period last year.——In an ad-

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dress to the stockholders of the Royal Dutch-Shell Co. in London, Sir Marcus Samuel is reported as having stated that his company would have to spend $5,000,000 in California for development of the properties recently purchased. Storage facilities, pipe-lines, and a refinery are to be built.——It is stated in advices from Coalinga that the California Oilfields, Ltd., has shut down some of its producing wells. This property has been under contract with the Standard Oil Co. Contract expired on November 15 and as the new owners, the Royal Dutch-Shell company, have not yet made disposition of the oil, it will be stored underground until shipping facilities have been provided.

Railways

San Francisco, Cal.—The California Railroad Commission has granted authority to the Clear Lake Railroad Co. to issue $500,000 in bonds and $261,700 in stock for the purpose of constructing a steam railroad from Hopland, Mendocino county, to Lakeport, Lake county, a distance of about 23½ miles. The cost of the road is estimated at approximately $742,000, of which $80,000 has already been expended. The road will be from Hopland, on the Northwestern Pacific railroad, across Russian river, up Dooly creek through Sanel valley, across a range of hills to the stock farm of Daniel Burns; thence across McDowell valley to the foot of the main range, over the mountain with a continuous maximum grade of 4% for a distance of 6 miles to the summit, at which point a 1300-ft. tunnel is planned; thence the road will run down the right bank of the Highland Springs creek to the bed of the stream and thence along the route of the Pieta toll road for two miles to Highland Springs; thence northerly to the west portion of Big valley, skirting the foothills to Lakeport. The route shows an unbroken 4% grade for about 6 miles going east and practically 3 miles going west with a maximum curvature of 24%. The Commission in granting authority has imposed several conditions, one of which requires that the company show that it can dispose of the stock for cash before selling the bonds. ——The city engineer has reported to the Board of Works that $1,280,000 should be made available before January 15, 1914, for municipal railway construction purposes and for the purchase of the Union-street car line. It is necessary that the following contracts be let at once: rails, railjoints, and fastenings, $250,000; tie rods and nuts, $5000; tie plates, $20,000; rail spikes, $5000; redwood cross-ties, $50,000; copper rail bonds, $10,000; track, special work, $200,000; trolley poles, $40,000; street-cars, $700,000.——Authority has been granted to the San Anselmo Valley Railway Co. to issue $55,000 of stock and $45,000 of bonds at par for the purpose of providing funds for the construction of a street railroad from the Union depot in San Rafael through the business portion of that town to San Anselmo and thence to Fairfax. No work may be commenced on the project until 90% of the stock and bonds has been subscribed and $50,000 paid in and placed in the bank.——The Tonopah & Tidewater Railroad Co. has asked authority of the Railroad Commission for permission to issue $294,000 of bonds for the purpose of constructing a line of narrow-gauge railroad, 17 miles in length, in Inyo county, California. The line will connect the Biddy McCarty borax mine with the Ryan branch of the Tonopah & Tidewater railroad.

Stockton, Cal.—The Tidewater & Southern Railway Co., on November 9, operated its first electric car between this city and Modesto. J. H. Wallace, chief engineer, and J. C. Lindsay, assistant engineer, were among the officials who made the first trip.

Red Bluff, Cal.—The Sacramento Valley Electric Railroad has applied to the State Railroad Commission for permission to issue securities for the purpose of obtaining funds for the construction of the first unit of the road which will be run from a point 12 miles south of Dixon on the Oakland-Antioch line to Woodland.

Vacaville, Cal.—The Northern Electric Railroad Co.'s branch from Suisun and Fairfield to Vacaville has been completed.

Los Angeles, Cal.—Contract has been awarded Robert Sherer & Co., Pacific Electric building, Los Angeles, by the Trona Railway for construction of the proposed 39-mile line; contract price, $400,000. W. A. Cattell, of San Francisco, is consulting engineer for the project, and Raymond Ashton is engineer in charge of construction in the field.

Portland, Ore.—The Oregon-Washington Railroad & Navigation Co. has announced that it will build two new railroad lines in 1914; one to South Bend and Raymond, Washington, and the other to Olympia. The line to Olympia will be built from a point on the main line now being completed be-

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tween Tenino and Tacoma, and will be about 8 miles long. Construction will start soon after January 1. The Tenino-Tacoma line is being built by the Northern Pacific for joint use with the O. W. R. & N. Co. The line to Raymond and South Bend will be 45 miles long and will connect with the Oregon-Washington line at Lincoln, 6 miles west of Centralia, on the new Gray's Harbor line. Surveys have been completed.

Spokane, Wash.—It is stated that work will be commenced not later than January 1 on the electrification of the Chicago, Milwaukee & St. Paul railroad. Construction plans and specifications have been submitted by the General Electric and Westinghouse companies. A contract will soon be awarded. The first installation will include the electrification of 113 miles of track from Bitter Root mountain. The remaining 450 miles from Harlowton, Montana, to Avery, Idaho, will be electrified within the next four years. The total expense is estimated at between $6,000,000 and $8,000,000.——The Northern Pacific railroad will complete the building of its Ellensburg to Ritzville line in the near future.

Salt Lake City, Utah.—The Salina Cañon Railroad Co. has been incorporated with an authorized capital stock of $1,000,000. The officers are: president, James Pingree, of Ogden; vice-president, E. P. Ellison, of Layton; treasurer, O. C. Beebe, of Salt Lake City; secretary, George S. Spencer, of Salt Lake City. It is planned to build a railroad 35 miles long east from Salina through Salina cañon. The road will be steam and the right-of-way provides a maximum grade of 4%.——It is stated that the Salt Lake & Alta railroad, from Midvale *via* Wasatch to the granite quarries of Little Cottonwood cañon has been completed. J. G. Jacobs is president and general manager.

Idaho Falls, Idaho.—A new electric railroad is projected between Idaho Falls through Lincoln and Ione to Poplar. From Lincoln a branch will run south about 9 miles to Taylor and Goshen. William C. Ross and L. J. Highland are promoting the project, while J. M. Rose, of Chicago, is the head of the financial syndicate that is providing funds. Contract has been let to W. D. Rogers for grading the section from Idaho Falls to Poplar, about 26 miles.

Lewiston, Idaho.—A bond issue of $50,000 is contemplated for the completion of the Johnson railroad.

Miscellaneous Engineering Construction

Richmond, Cal.—Bids will be received on December 29 for the construction of the greater portion of the municipal tunnel and highway. The cost of the work covered by these bids is estimated at $250,000, and the entire cost of the tunnel and highway projects with docks and warehouses on the outer harbor is estimated at $450,000. Work is to be commenced on the highway from the south side of Richmond avenue to the north portal of the proposed tunnel, continuing with the tunnel work through the hill section and on with the highway about 1000 feet.

Red Bluff, Cal.—The county supervisors have awarded a contract to Bone & Lanning, of this city, for constructing a wooden bridge over Reed creek for the sum of $1048.

Stockton, Cal.—A. L. Harlow, of San Francisco, and his associates, G. E. Tuman and E. W. Dwinnell, have announced that they will construct a 100-ft. dam on the Calaveras river, two miles south of Valley spring, to impound water for irrigation purposes.

Willows, Cal.—The county supervisors have let contracts for bridges as follows: The Newville bridge to M. Concanon, of San Francisco, for $16,197; the Shelton bridge at Newville to M. Concanon for $7791; the Walker Creek bridge to the Ross Construction Co. for $6706.

Redding, Cal.—The city trustees have authorized the Ross Construction Co., of Sacramento, to prepare and submit plans and specifications for the proposed bridge at Reed's ferry.

Oroville, Cal.—A joint bridge is contemplated by the Northern Electric Railway and the county officials over the Feather river below this city.

Spokane, Washington.—Contract has been awarded to the Oregon Bridge & Construction Co., of Portland, for the construction of a new bridge for the Spokane, Portland & Seattle railway over the Milwaukee tracks at Waukee at a cost of about $15,000. W. C. Mock is resident engineer for the railroad company.——Three bridges at Farmington are nearing completion.——Porter Bros. have been awarded a contract at a cost of about $70,000 for a 400,000-yd. rock and earth fill for the bridge at Glavin.——The Guthrie-McDougall Co. is constructing a 24-ft. reinforced concrete arch for the road crossing at Brickyard gulch. The Guthrie-McDougall

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Co. is filling five bridges at a cost of about $80,000.

Salt Lake City, Utah.—It is proposed that specifications be drawn up for the proposed viaduct over the Oregon Short Line tracks at Second North street. The city engineering department is carrying on the work.—— Plans are being made for concreting about 13 miles of ditch for the Twin Falls North Side irrigation project, one of the properties controlled by the Kuhns of Pittsburg. William McGinnis, of Jerome, Idaho, is in charge of the project. It has been calculated that more than 33% of the water that runs through the ditch in its present condition is lost by evaporation and seepage before reaching the storage reservoir at Jerome. Plick Bros., engineer contractors, are looking over the ditch preparatory to making a bid for this work.

Power, Gas, and Electricity

San Francisco, Cal.—It has been announced by D. A. Chappelle, president of the Nevada-California Power Co., that funds have been obtained for refinancing the company and its consolidation with the Southern Sierra Power Co. The new company will have authorized capital stock of $5,000,000, together with a bond issue sufficient to provide funds for all needed extensions for several years to come.

Winters, Cal.—The Winters Gas Co. has applied to the Railroad Commission for permission to issue $25,000 in stock to provide funds for erecting a gas plant in this city.

Redding, Cal.—The Pit River Power Co. will re-apply for a franchise for the purpose of utilizing the water at Burney Falls for the generation of electric power. The power is to be used in pumping water from the Pit river for irrigation purposes. The officers of the company are John H. Logan, John F. Sheehan, Jr., and William T. Jeter.

Spokane, Washington.—Preliminary surveys for the location of a municipal power-plant have been commenced by Morton Macartney, city engineer. Two sites are being considered, one at the Narrows near the Spokane site of the Columbia river, and the other at a point approximately 14 miles nearer the city. It is stated that at the Narrows site a 70-ft. dam can be constructed and that little valuable agricultural land will be submerged thereby. The Narrows power site is held under government grant by the Big Bend Rapid Transit Electric Railway Co., of which William Nichols, of Spokane, is president. Work was started by this company about eight years ago, but litigation has since deterred development of the power site. A transmission line 63 miles long will be required to convey the power along the water grade route following the Spokane river. It is stated that a 100-ft. dam would submerge all of the agricultural land for 7 miles up the river from Miles.

North Yakima, Washington.—It has been announced that a hearing by the State Public Service Commission on the physical valuation of the electric service properties of the Pacific Power & Light Co. in the state of Washington will be held in North Yakima some time in January. Twenty-two cities and towns are plaintiffs in the complaint concerning rates. Mr. Burroughs, state engineer, and his associates are making a report on the valuation.

Salt Lake City, Utah.—The Citizens Heat & Power Co., represented by Robert S. Campbell, has applied for a franchise for the installation of a plant for furnishing heat and power. The company plans to erect one central power station, together with complete distribution system for electric light and power service and steam for heating. The initial installation is to carry steam to that territory from Fifth South and Second East streets west to Third West street, north to Current street, east to Sixth avenue and B street, and south to Fifth South and Second East street.

Boise, Idaho.—It has been announced that the Beaver River Power Co. has been sold to the Idaho Railway Light & Power Co., which is a holding company for the Idaho Traction Co. The latter in turn controls the stock of the Idaho-Oregon Light & Power Co. The consideration is said to have been approximately $500,000. This deal gives the Idaho-Oregon company complete control of western Idaho territory.

Helena, Montana.—The Montana Public Service Commission has decided to hold hearings at which rates for electricity will be investigated. The companies involved are the Montana Power Co. and its subsidiaries; the Northern Idaho & Montana Power Co., and the Missoula Light & Water Company.

Nelson, B. C.—Property owners have voted to purchase for $50,000 the Nelson Gas & Coke Co.'s plant. It is stated that the original cost of the property conveyed was in excess of $100,000. This city now owns an electric plant, gas plant, and water works.

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Streets and Roads

Sacramento, Cal.—The following bids were received for sections of the state highway on October 20:

Humboldt County—Div. 1, Route 1, Sec. A.

Fairbanks & Baechtel, Willits, Cal.	$50,639.00
F. H. Green, Eureka, Cal.	57,959.00
Geo. H. Bradner, San Francisco.	59,792.70

Riverside County—Div. VII, Route 19, Sec. A.

Highway Construction Co., Highlands	$53,789.25
W. A. Dontanville, Pasadena	46,438.25
P. A. & C. H. Howard, Los Angeles.	39,963.80
Johnson-Shea Co., Riverside	48,306.50
James M. Montgomery Const. Co., Alhambra	38,723.60
Bent & Pennebaker, Los Angeles.	54,771.60
The M. R. Co., Inc., Los Angeles.	36,878.75
Geo. S. Benson & Sons, Los Angeles	43,434.00
John D. Marsh, Los Angeles	63,989.50
Rogers Bros. Co., Los Angeles	44,436.25

The following bids were received on November 17:

Fresno County—Div. VI, Route 4, Sec. B.

W. A. Dontanville, Pasadena	$67,847.00
Geo. S. Benson & Sons, Los Angeles	66,561.00

Fresno County—Div. VI, Route 4, Sec. A.

A. Teichert & Son, Sacramento	$39,695.60
Geo. W. Martin & Son, Sacramento	45,565.80

Fresno County—Div. VI, Route 4, Sec. B.

A. B. Munson & Son, Stockton	$42,597.50
A. Teichert & Son, Sacramento.	36,551.00

San Bernardino County—Div. VII, Route 9, Sec. A.

Theo. F. White, Los Angeles	$49,470.50
B. A. Davison Cont. Co., Monrovia	59,882.28
A. C. St. John, Los Angeles	56,963.00
Geo. S. Benson & Sons, Los Angeles	66,016.60
Jas. M. Montgomery Const. Co., Alhambra	51,694.58
Highway Const. Co., Highlands.	51,634.50
Rogers Bros. Co., Los Angeles	59,777.00
Hudson-Johnson Const. Co., Los Angeles	48,928.80
P. A. & S. H. Howard, Los Angeles.	49,201.30

San Luis Obispo County—Div. V, Route 2, Sec. A.

W. A. Dontanville, Pasadena	$87,665.00
Burns, Clark & Da Rosa Pav. Co., Sacramento	93,995.50
Geo. S. Benson & Sons, Los Angeles	89,897.00

Santa Barbara County—Div. V, Route 2, Sec. H.

Taylor & Berliner, Los Angeles.	$18,808.50
Rogers Bros. Co., Los Angeles	21,668.00
Occidental Const. Co., Los Angeles.	13,705.00

Willows, Cal.—A connecting link in a trans-mountain road between Glenn, Tehama, and Humboldt counties is to be built; $2500 has been appropriated by the federal government and $5,000,000 by Tehama county. Mr. Luning is county engineer and D. P. Goodwin is supervisor of the California National Forest.

Helena, Cal.—B. H. Burrell, senior highway engineer of public roads, U. S. Department of Agriculture, with a corps of surveyors, is establishing the final grade for the down-river wagon-road from North Fork to South Fork, a distance of 40 miles. A portion of this road is now under course of construction and when completed will afford the most direct route from Redding, in the Sacramento valley, to Eureka on the coast, the river portion being a summer and winter route, and on a grade of 3% means much toward the future development of the district. The districts directly benefited are Canyon Creek, East Fork, Rattlesnake, Grizzly, New River, and the immense gravel deposits along the entire length of the road. Weaverville and vicinity, the most densely populated portion of the country, also will receive direct benefit through the very material reduction in freight rates *via* ocean route to Eureka, thence by team and autotrucks, as compared with the present rail route to Redding and over the heavy grades by team to Weaverville. Trinity county is assisting, but the construction is being principally done by the Government, $50,000 now available having been set aside from the Forest Service refund money, and more is to follow next year.

Milton, Oregon.—The City Council has ordered grading of Fair street east.

Pullman, Washington.—The City Council has passed a resolution declaring its intention to pave Grand street from the south line of Center street to the north line of Cleveland street; Main street from the east line of Grand street to the west line of Spring street; Alder street from the north line of Paradise street to the south end of Kamiaken street bridge; Olson street from the east line of Grand street to the west line of Alder street; west Main street from Grand street to the city limits. Work will be started in the early spring.

Olympia, Washington.—The highway commission has approved Sunset highway from Reardan to Davenport, 13 miles, and from Davenport westerly 6 miles. W. J. Roberts, highway commissioner, has been directed to

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call for bids. The approximate cost will be $70,000.——The route from Colfax to Rosalia by way of Thornton for the Inland Empire Highway has been selected in preference to the Oaksdale route.——The improvement of a mile of the sand-clay road by gravel north of Rosalia has been ordered at a cost of $500.

Wenatchee, Washington.—The city engineer has been authorized to grade Idaho and King streets to the city limits, and also to grade and gravel 5th street from Miller street to Wenatchee avenue.

Wallace, Idaho.—The City Council has decided to pave all city streets as expeditiously as possible. An ordinance has been passed providing for the paving of 6th street from Cedar street north to the Northern Pacific bridge at a cost not to exceed $1.70 per square yard.

Kellogg, Idaho.—The county commissioners have made plans for the construction of a new road from Kingston to a point near Cataldo. J. B. Cox is county commissioner having the work in charge.

Moscow, Idaho.—The City Council is considering the installation of paved streets in the Fourth Improvement district. The new pavement is to run east on Spotswood street to Adams; south on Adams to Veatch; east on Veatch to Harrison; south on Harrison to McGregor; east on Railroad street to the city limits. All paving in residential sections is to be 30 ft. wide, with parking strips on either side.

Spokane, Washington.—During the grading season just closed, 135 miles of improved city streets were scraped, regraded, leveled, and the gutters cleaned at a cost of about $85 per mile. Z. E. Hayden is street commissioner and L. S. Murphy is street superintendent.

Salt Lake City, Utah.—Governor William Spry is investigating the possibilities of a direct road between Moab and Monticello in San Juan county.——The county commissioners have decided to employ a road expert to check the report by B. H. Burrell of the Division of Roads, U. S. Department of Agriculture, dealing with proposed expenditure of $1,000,000 for the improvement of roads of Salt Lake county. H. A. Gardner, county surveyor, and Willard Snow, road superintendent, have also been called in to pass upon the report.——Surveys for the proposed new route for the section of state highway from the Summit county line to the Tooele county line, *via* Parleys' cañon, have been completed.——Plans have been practically completed for a new state road which will connect Salt Lake with Summit county. E. R. Morgan is state road engineer. The new road will be about 15 miles long and cost $25,000. Francis M. Lyman, Jr., is engaged in compilation of the map showing exact details of the route.

Ogden, Utah.—Butler avenue is to be paved for the remainder of the distance between 25th and 26th streets paralleling Adams and Jefferson avenues. The cost will be approximately $3000. H. J. Craven is city engineer.

Brigham City, Utah.—Various improvements are to be made in the Grouse Creek road district by the Box Elder county commissioners.

Irrigation and Water Supply

San Francisco, Cal.—The consent of four-fifths of the bondholders of the Natomas Consolidated of California has been requested to enable the company to abstain from making a payment into its sinking fund until January 1919, in order that the company may commence farming the 40,000 acres of land which it owns north of Sacramento in the American river basin. The total bonds outstanding are $14,015,000, and the consent of 80% of the bondholders is required.

Davis, Cal.—The Davis Water Co. has taken over the city water system from Schmeiser Manufacturing Co. The new company proposes to install a larger pumping plant, a concrete standpipe 108 ft. high, and a reservoir of 50,000-gal. capacity. The reservoir beneath the fire reservoir will have a capacity of 250,000 gal. Six-inch mains with 4-in. laterals are to be laid through the town.

Antioch, Cal.—A new municipal water system is to be installed for which funds in the form of a bond issue amounting to $25,000 have been provided.

Montague, Cal.—A bond issue of $25,000 for the purpose of installing a water system has been authorized.——A request is to be made of Congress to appropriate $5,000,000 for carrying out an irrigation project embracing 100,000 acres in twelve townships, north, south, and east of this city, by means of the construction of a canal of 40,000 miner's inches capacity that will draw its supply of water from the Klamath river at Keno, 35 miles northeast of Montague. As the intake of the proposed canal will be 1400 ft. above the floor of the valley, ap-

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proximately 40,000 electrical horse-power may be developed. John T. Whistler, engineer for the U. S. Reclamation Service, and John Felleman, of Red Bluff, are assisting in promoting the project.

Fort Bidwell, Cal.—A contract has been awarded to George Thompson for enlarging the Fee dam on the east side of Surprise valley. The height is to be increased 1 ft., the base to be broadened 8 ft., and the crest 5 ft. The dam will be 12 ft. wide at the top when completed, and is 765 ft. long, being of the rock and earth-fill type.

Red Bluff, Cal.—Lewis Newcomer, of Corning, has sold to A. B. Aitken a tract of 1723 acres on Thomas creek in Tehama county. This land is to be placed under irrigation. Pumping plants will be built.

Oroville, Cal.—A number of land-owners have met to take preliminary steps for the organization of a 60,000-acre irrigation district for land situated to the south and west of Oroville. George P. Morse is chairman and A. H. Davis is secretary.

Sacramento, Cal.—Reclamation district No. 784 has made application to the State Reclamation Board for approval of their plans for levee work. Jason R. Meek is engineer and J. E. Ebert is secretary for the project. The board has taken the matter under consideration.

Gridley, Cal.—James and John Myers are planning to install a large pumping plant and construct a reservoir on their property west of Gridley; 12-in. reinforced concrete pipe is to be installed for a distance of 6 miles to conduct water for irrigation purposes.

Spokane, Washington.—A contract has been let by the Hillyard city council to the James Kennedy Construction Co. for complete new water mains to be installed at a cost of $88,000.

Palouse, Washington.—The City Council has authorized the fire and water committee to purchase new water pipe for the repair of various city water mains.

Ogden, Utah.—Contract has been awarded to Andrew Ashton for the construction of the Wheeler creek pipe-line at a cost of $3288.77.——Articles of incorporation have been filed for the New Era Irrigation Co. The officers are: Stephen Knight, Plain City; James M. Wade, Warren; W. J. Coy, Plain City; Lyman Skeen, Plain City; M. W. Wade, Warren; Charles Skeen, Plain City; Joseph Skeen, Warren; D. A. Skeen, Salt Lake City.

Brigham City, Utah.—The city has commenced construction of a water works system in the town of Corinne, 7 miles west of Brigham City.

Provo, Utah.—The directors of the Utah Lake Irrigation Co. have decided to extend the canal system in Salt Lake county to the east side of the valley. A canal will be built from the company's main canal west of Jordan near the Lambson power-plant site, thence east to Draper, and thence north past Sandy to Cottonwood. The water will be conveyed across the Jordan river in an inverted siphon 4000 ft. long with a capacity of 80 second-feet.

Great Falls, Montana.—Construction work has commenced on the excavation for the Sun River diversion dam. H. N. Savage is supervising engineer of the U. S. Reclamation Service for this project.

Washington, D. C.—According to an order issued by Franklin K. Lane, Secretary of the Interior, 111,860 acres of land embraced in the Iron Cañon irrigation project have been withdrawn from any disposition under the public lands act, pending investigations now under way jointly by the U. S. Government and state of California. The lands lie in Townships 28, 29, 30, and 31, Ranges 2, 3, and 4 West.

Personal

WILLIAM C. FLEISHER is going to Venezuela to take charge of the Barber Asphalt Co.'s work.

W. D. BEERS, state engineer for Utah, has returned from a month's inspection trip throughout the interior of the state.

CHARLES H. LEE, consulting civil and hydraulic engineer, has removed his offices to No. 1103 Central building, Los Angeles.

M. M. O'SHAUGHNESSY, city engineer for San Francisco, has gone to Washington, D. C., on matters connected with the Hetch-Hetchy water-supply project.

W. L. DARLING, chief engineer for the Northern Pacific railroad, has been one of a board recently engaged in an inspection trip over the Camas Prairie lines.

L. W. LOEHR is president of the Washington State Association of County Engineers, and presided at the sessions recently held at North Yakima on November 17.

LE GRAND BROWN has opened offices at 1307 Claus Spreckels building, San Francisco, where he will engage in the practice of consulting engineer with special reference

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to electric railways, power installations, irrigation projects, and municipal improvements.

RUDOLPH R. POLLAK, consulting petroleum engineer of San Francisco, has gone to Tampico, Mexico, to become general manager for the Cortez Petroleum Syndicate, Ltd.

F. E. WILDER, chief engineer for the American Petroleum Co., at Coalinga, was accidentally killed on November 16, by being caught in the gearing of a water pump.

GEORGE M. BRILL, consulting refrigeration engineer of Chicago, recently addressed the engineering students at Stanford University on the subject of 'Engineering of Manufacturing Plants.'

CHARLES GILMAN HYDE has been in conference with the Sacramento Chamber of Commerce and the City Commission with regard to the proposed new water-supply for the city of Sacramento.

MORTON MACARTNEY, city engineer, and A. LINDSAY, water superintendent for Spokane, Washington, have been inspecting the proposed power site at Narrows for the municipal light and power-plant.

CHAS. E. VAN BARNEVELD, director of the Department of Mines and Metallurgy of the Panama-Pacific Exposition, has returned from a tour of the East on business connected with the proposed petroleum exhibit.

C. E. GRUNSKY, Jr., has returned from the Standard Consolidated mines at Bodie, California, to take charge of the mining engineering section of the American Engineering Corporation of San Francisco.

J. B. INGERSOLL, of Spokane, Washington, has been retained as consulting engineer for the compilation of data with reference to possible action by the city in rate cases against the Washington Water Power Co. of Spokane.

Society Meetings

THE ENGINEERS' CLUB of San Francisco opened its new quarters at the Hotel Sutter on Saturday evening, November 15, by an informal dinner at which there were 82 in attendance. The Entertainment Committee arranged a program somewhat in accordance with that usually conducted by the Gridiron Club of Washington, D. C. During the course of the dinner a number of amusing fake telegrams were read and a question box was inaugurated that gave most remarkable answers to some very serious questions. After the dinner was over, the evening's entertainment consisted of a burlesque drilling contest for the amusement of the mining engineers present. A hearing was then held before the 'Municipal Clinic' at which the question of inductive interference between communication and power lines was discussed with the assistance of a toy telephone transmitter, a telephone, and a power line artistically constructed with the aid of some borrowed insulators and broomstick poles. The geologists and petroleum engineers had an opportunity of showing their specialty before an admiring audience by means of a miniature oil rig. The formation of a box of sand was the subject of careful scrutiny and study by the geologists. The well was drilled, and, with the assistance of a few firecrackers and a siphon bottle was brought in and proved to be a veritable gusher. The electrification of the railway over Tehachapi pass by means of a single-phase system was the subject of another discourse with the aid of a model constructed of old packing boxes covered with burlap besprinkled with toy trees, and upon which a tentative right-of-way had been established and track laid. While most of the byplay was of purely a local character, everyone present seemed to enjoy the occasion. In fact, as a Stanford University freshman, who had attended the dinner with his father, remarked, "They acted like a lot of kids."

Commercial Paragraphs

PACIFIC TANK & PIPE CO. announces that it has moved its San Francisco sales offices from Fifth and Bryant streets to the offices formerly occupied at 318 Market street.

HAUCK MFG. CO. has moved its San Francisco office to 111 Main street, where improved facilities will be afforded for demonstrating kerosene torches and oil-burning appliances.

Catalogues Received

CONLEY INCINERATING SYSTEM, Phelan Bdg., San Francisco. Illustrated catalog referring to the advantages of incineration as a sanitary measure and with special reference to detailed data concerning the Conley incinerator.

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